Evidence Portfolio – Chronic Conditions Subcommittee, Question 4

In individuals with type 2 diabetes, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, (3) health-related quality of life, and (4) disease progression?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
c. Does the relationship vary based on: frequency, duration, intensity, type (mode), or how physical activity is measured?

Sources of Evidence: Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis

Conclusion Statements and Grades

RISK OF CO-MORBID CONDITIONS
Strong evidence demonstrates an inverse association between volume of physical activity and risk of cardiovascular mortality among adults with type 2 diabetes. **PAGAC Grade: Strong.**

Moderate evidence indicates an inverse, curvilinear dose-response relationship between physical activity and cardiovascular mortality among adults with type 2 diabetes. **PAGAC Grade: Moderate.**

Insufficient evidence was available to determine whether the relationship between physical activity and cardiovascular mortality among adults with type 2 diabetes varies with age, sex, race/ethnicity, socioeconomic status, or weight status. **PAGAC Grade: Not assignable.**

Insufficient evidence was available to determine whether the relationship between physical activity and cardiovascular mortality among adults with type 2 diabetes varies with frequency, duration, intensity, or type (mode) of physical activity or how physical activity is measured among people with type 2 diabetes mellitus. **PAGAC Grade: Not assignable.**

PHYSICAL FUNCTION
Insufficient evidence was available to determine the relationship between physical activity and physical function in adults with type 2 diabetes. **PAGAC Grade: Not assignable.**

HEALTH-RELATED QUALITY OF LIFE
Insufficient evidence was available to determine the relationship between physical activity and health-related quality of life in adults with type 2 diabetes. **PAGAC Grade: Not assignable.**

DISEASE PROGRESSION
Insufficient evidence was available to determine the relationship between physical activity and indicators of progression of neuropathy, nephropathy, retinopathy, and foot disorders. **PAGAC Grade: Not assignable.**

Strong evidence demonstrates an inverse association between aerobic activity, muscle-strengthening activity, and aerobic plus muscle-strengthening activity with risk of progression among adults with type

2 diabetes, as assessed by overall effects of physical activity on four indicators of risk of progression: glycated hemoglobin A1C, blood pressure, body mass index, and lipids. **PAGAC Grade: Strong.**

Insufficient evidence was available to determine the relationship between tai chi, qigong, and yoga exercise on four indicators of risk of progression: hemoglobin A1C, blood pressure, body mass index, and lipids. **PAGAC Grade: Not assignable.**

Moderate evidence indicates an inverse dose-response relationship between volume of aerobic activity and two indicators of risk of progression—blood pressure and hemoglobin A1C —among adults with type 2 diabetes. **PAGAC Grade: Moderate.**

Limited evidence indicates an inverse dose-response relationship between volume of resistance training and one indicator of risk of progression— hemoglobin A1C —among adults with type 2 diabetes. **PAGAC Grade: Limited.**

Limited evidence indicates that longer periods of consistent physical activity have a larger effect on three indicators of risk of progression— hemoglobin A1C, body mass index, and lipids—than do shorter periods among adults with type 2 diabetes. **PAGAC Grade: Limited.**

Moderate evidence indicates that the effects of physical activity on the disease progression indicator of blood pressure are larger in hypertensive individuals with type 2 diabetes than in those without hypertension. Similarly, moderate evidence indicates that the effects of physical activity on the disease progression indicator of hemoglobin A1C are larger in individuals with type 2 diabetes who have higher levels of hemoglobin A1C than in those with lower hemoglobin A1C. **PAGAC Grade: Moderate.**

Insufficient evidence was available to determine whether the effects of physical activity on indicators of risk of progression in adults of type 2 diabetes vary by age, sex, race/ethnicity, socioeconomic status, or weight status. **PAGAC Grade: Not assignable.**

Limited evidence suggests, when adults with type 2 diabetes engage in equal amounts of moderate-intensity and vigorous-intensity aerobic activity, vigorous-intensity activity is more efficient than moderate-intensity activity in improving one indicator of risk of progression— hemoglobin A1C. **PAGAC Grade: Limited.**

Insufficient evidence was available to determine the effects of frequency, bout duration, and method of measuring physical activity on indicators of risk of progression in adults with type 2 diabetes. **PAGAC Grade: Not assignable.**

Description of the Evidence

The Chronic Conditions Subcommittee chose to rely exclusively on existing reviews including systematic reviews, meta-analyses, pooled analyses, and reports for this question. Additional searches for original research were not conducted based on the a-priori decision to focus on existing reviews.

RISK OF CO-MORBID CONDITIONS

Existing Meta-Analyses and Pooled Analysis

Overview

A total of 3 existing reviews were included: 2 meta-analyses[1, 2] and 1 pooled analysis.[3] The reviews were published between 2012 and 2014.

The meta-analyses included 17[1] and 12[2] studies and covered the following timeframe: from 1950 to 2011[1] and from inception to 2010.[2]

The pooled analysis[3] used 7 years of data from the Health Survey for England, and 3 years of data from the Scottish Health Survey.

Exposures

The included reviews examined the effects of physical activity (in metabolic equivalent hours per week) on the risk for co-morbid conditions in individuals with type 2 diabetes. Sluik et al[2] assessed walking, total, and leisure-time physical activity. Sadarangani et al[3] examined self-reported physical activity in 3 domains: sports and exercise, walking, and domestic physical activity.

Outcomes

One meta-analysis[1] examined the risk of incident cardiovascular disease and all-cause mortality. One meta-analysis[2] and the pooled analysis[3] assessed all-cause and cardiovascular disease mortality.

PHYSICAL FUNCTION

Existing Systematic Review

Overview

One systematic review[4] addressed physical function in individuals with type 2 diabetes and peripheral neuropathy.

The review included 10 studies and covered a timeframe from inception to 2016.

Exposures

The review examined fall prevention exercise programs using different modalities, including lower limb strengthening, balance exercises, walking programs, and tai chi.

Outcomes

The studies included in the review examined muscle strength and balance. Other outcomes included the 6-minute walk test and number of falls.

HEALTH-RELATED QUALITY OF LIFE

Existing Systematic Reviews and Meta-Analyses

Overview

A total of 6 existing reviews addressing health-related quality of life in individuals with type 2 diabetes were included: 3 systematic reviews[5-7] and 3 meta-analyses.[8-10] The reviews were published between 2011 and 2017.

The systematic reviews included a range of 20–30 studies and covered the following timeframes: inception to 2016,[5] inception to 2015,[6] and inception to 2012.[7]

The meta-analyses included a range of 12–22 studies and covered the following timeframes: inception to 2011,[8] inception to 2014,[9] and 2002 to 2012.[10]

Exposures

All the included reviews assessed physical activity performed in various modalities. Two reviews examined exercise training programs,[5, 7] one examined yoga,[6] and two examined tai chi.[8, 9] Plotnikoff et al[10] assessed community-based interventions, including general exercise programs, walking programs, resistance training, and yoga classes.

Outcomes

All the included reviews examined health-related quality of life.

DISEASE PROGRESSION

Existing Systematic Reviews and Meta-Analyses

Overview

A total of 34 existing reviews addressing disease progression in individuals with type 2 diabetes were included: 7 systematic reviews[6, 11-16] and 27 meta-analyses.[8-10, 17-40] The reviews were published between 2011 and 2017.

The systematic reviews included a range of 5–23 studies and covered the following timeframes: 1990 to 2014,[11] 1990 to 2015,[12] 1992 to 2010,[13] 2004 to 2011,[14] inception to 2015,[6] 2000 to 2015,[15] and 1966 to 2011.[16]

The meta-analyses included a range of 3–47 studies and covered the following timeframes: inception to 2012[17, 23, 38]; 1945 to 2016[18]; 1970 to 2009[19]; inception to 2016[20, 22, 28, 29]; 1980 to 2011, 2012, and 2013[21, 35, 36]; inception to 2011[8, 24]; inception to 2014[9, 25, 27, 33, 34]; 1960s to 2014[26, 31]; 1946 to 2013[30]; 2002 to 2012[10]; 1994 to 2013[32]; inception to 2015[37, 40]; and inception to 2013.[39]

Exposures

The included reviews examined various modalities of physical activity. Ten reviews assessed aerobic and resistance exercise programs.[12, 15, 16, 19, 21-23, 25, 34-36, 39, 40] Four reviews focused on resistance training.[24, 26, 28, 30] Eight reviews focused on mind-body exercises such as yoga, qigong, or tai chi.[6, 8, 9, 13, 20, 27, 37, 38] Three reviews used pedometer- or accelerometer-based interventions.[14, 18, 32]

Outcomes

The majority of the reviews examined glycemic control as an outcome. Other outcomes included body composition measures (e.g., body mass index), changes in systolic and diastolic blood pressure, and lipid profile.

Populations Analyzed

The table below lists the populations analyzed in each article.

Table 1. Populations Analyzed by All Sources of Evidence

	Race/ Ethnicity	Age	Weight Status	Chronic Conditions
Avery, 2012		Adults ≥18		Type 2 Diabetes
Baskerville, 2017		Adults 35–89		Type 2 Diabetes
Bhurji, 2016	South Asian (India, Pakistan, Bangladesh)	Adults 35–66		Type 2 Diabetes
Byrne, 2017				Type 2 Diabetes
Cai, 2017		Adults ≥18		Type 2 Diabetes
Chudyk, 2011		Adults ≥18		Type 2 Diabetes
Cui, 2017		Adults		Type 2 Diabetes
Figueira, 2014		Adults ≥18		Type 2 Diabetes
Freire, 2013				Type 2 Diabetes
Funk, 2013		Adults 18–89		Type 2 Diabetes
Grace, 2017		Adults >18		Type 2 Diabetes
Gu, 2017		Adults		Peripheral neuropathy; Type 2 Diabetes
Hayashino, 2012		Mean age 56.7		Type 2 Diabetes
Hovanec, 2012		Mean age ≥65		Type 2 Diabetes
Huang, 2016		Adults 50–67.3		Type 2 Diabetes
Innes, 2016		Adults		Type 2 Diabetes
Ishiguro, 2016	European and American countries vs. others	Adults ≥55, <55	BMI ≥32 vs. <32	Type 2 Diabetes
Kodama, 2013		Adults <60; ≥60	Overweight (BMI: 25–29.9)	Type 2 Diabetes
Kumar, 2016		Adults 30–75		Type 2 Diabetes
Lee, 2017		Adults ≥60		Type 2 Diabetes

	Race/ Ethnicity	Age	Weight Status	Chronic Conditions
Lee, 2011				Type 2 Diabetes
Lee, 2015		Adults ≥18		Type 2 Diabetes
Liubaoerjijin, 2016		Adolescents, Adults		Type 2 Diabetes
McGinley, 2015		Adults		Type 2 Diabetes
Pai, 2016		Adults 35–71		Type 2 Diabetes
Plotnikoff, 2013		Adults ≥18		Type 2 Diabetes
Qiu, 2014a		Adults		Type 2 Diabetes
Qiu, 2014b		Adults		Type 2 Diabetes
Rohling, 2016				Type 2 Diabetes
Sadarangani, 2014		Adults ≥50		Type 2 Diabetes
Schwingshackl, 2014		Adults ≥19	Obese (BMI: ≥30)	Type 2 Diabetes
Sluik, 2012		Adults 30–75		Type 2 Diabetes
Sukala, 2012		Mean age 41–66		Type 2 Diabetes
Umpierre, 2011		Adults >18		Type 2 Diabetes
Umpierre, 2013		Adults >18		Type 2 Diabetes
van der Heijden, 2013		Adults ≥18		Type 2 Diabetes
Vizcaino, 2016		Adults 30–78		Type 2 Diabetes
Yan, 2013				Type 2 Diabetes
Yang, 2014		Adults ≥18		Type 2 Diabetes
Zou, 2016			Obese (BMI: ≥30)	Type 2 Diabetes

Supporting Evidence

Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis

Table 2. Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis Individual Evidence Summary Tables

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Avery L, Flynn D, van Wersch A, Sniehotta FF, Trenell MI. Changing physical activity behavior in type 2 diabetes: a systematic review and meta-analysis of behavioral interventions. Diabetes Care. 2012;35(12):2681-2689. doi:10.2337/dc11-2452.</td></tr>
<tr><td>Purpose: To determine whether behavioral interventions are more effective than standard clinical care for improving “free-living” PA, exercise, and hemoglobin A1c in adults with type 2 diabetes in clinical or community settings.</td><td rowspan="5">Abstract: OBJECTIVE: Behavioral interventions targeting “free-living” physical activity (PA) and exercise that produce long-term glycemic control in adults with type 2 diabetes are warranted. However, little is known about how clinical teams should support adults with type 2 diabetes to achieve and sustain a physically active lifestyle. RESEARCH DESIGN AND METHODS: We conducted a systematic review of randomized controlled trials (RCTs) (published up to January 2012) to establish the effect of behavioral interventions (compared with usual care) on free-living PA/exercise, HbA(1c), and BMI in adults with type 2 diabetes. Study characteristics, methodological quality, practical strategies for increasing PA/exercise (taxonomy of behavior change techniques), and treatment fidelity strategies were captured using a data extraction form. RESULTS: Seventeen RCTs fulfilled the review criteria. Behavioural interventions showed statistically significant increases in objective (standardized mean difference [SMD] 0.45, 95% CI 0.21-0.68) and self-reported PA/exercise (SMD 0.79, 95% CI 0.59-0.98) including clinically significant improvements in HbA(1c) (weighted mean difference [WMD] -0.32%, 95% CI -0.44% to -0.21%) and BMI (WMD -1.05 kg/m(2), 95% CI -1.31 to -0.80). Few studies provided details of treatment fidelity strategies to monitor/improve provider training. Intervention features (e.g., specific behavior change techniques, interventions underpinned by behavior change theories/models, and use of >/=10 behaviour change techniques) moderated effectiveness of behavioral interventions. CONCLUSIONS: Behavioral interventions increased free-living PA/exercise and produced clinically significant improvements in long-term glucose control. Future studies should consider use of theory and multiple behavior change techniques associated with clinically significant improvements in HbA(1c), including structured training for care providers on the delivery of behavioural interventions.</td></tr>
<tr><td>Timeframe: Inception–January 2012</td></tr>
<tr><td>Total # of Studies: 17</td></tr>
<tr><td>Exposure Definition: Behavioral interventions targeting free-living PA and exercise.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Changes in hemoglobin A1c.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults ≥18; Type 2 diabetes</td><td>Author-Stated Funding Source: European Union Seventh Framework Programme.</td></tr>
</table>

Meta-Analysis **Citation:** Baskerville R, Ricci-Cabello I, Roberts N, Farmer A. Impact of accelerometer and pedometer use on physical activity and glycaemic control in people with Type 2 diabetes: a systematic review and meta-analysis. Diabet Med. 2017;34(5):612-620. doi:10.1111/dme.13331.	
Purpose: To review systematically the impact of accelerometer and pedometer use on free-living PA and hemoglobin A1c in people with type 2 diabetes.	**Abstract:** Background Self-directed pedometer use increases physical activity levels in the general population; however, evidence of benefit for Type 2 diabetes is unclear and has not been systematically reviewed for accelerometers. Aim To examine the impact of using physical activity monitoring devices (pedometers and accelerometers) on free-living physical activity and HbA1c levels in people with Type 2 diabetes. Methods We conducted a systematic literature review. Bibliographic databases included Medline, Embase, Web of Science, CINAHL, SportDiscus and the Cochrane Central Register of Controlled Trials. We included controlled trials evaluating interventions based on the use of pedometers or accelerometers to promote physical activity in people with Type 2 diabetes. Primary outcomes were physical activity (min/week or steps) and HbA1c [mmol/mol (%)]. Secondary outcomes were weight, blood pressure and lipid profile. Results Twelve trials (1458 participants) were identified, of which nine studied pedometers and three accelerometers. Random-effects meta-analysis showed an overall increase in physical activity (standardized mean difference 0.57, 95% CI 0.24, 0.91) in the intervention groups. Accelerometers and pedometers produced a similar effect size. No significant differences were observed in HbA1c, BMI, blood pressure or lipid profile. Conclusions People with Type 2 diabetes, provided with an accelerometer or pedometer, substantially increased their free-living physical activity. There is no evidence that monitor use alone improves HbA1c or other clinical outcomes. Further trials are needed to compare the relative effects of activity monitors within differing complex interventions.
Timeframe: 1945–August 2016	
Total # of Studies: 12	
Exposure Definition: Exercise interventions based on use of activity monitors (i.e,. pedometers, accelerometers) to promote PA. The mean length of the intervention, including follow-up, was 8 months, and ranged from 5 weeks to 18 months. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No	
Outcomes Addressed: Hemoglobin A1c [mmol/mol (%)], weight, body mass index (kg/m2), blood pressure (mm/Hg), and lipid profile. **Examine Cardiorespiratory Fitness as Outcome:** No	
Populations Analyzed: Adults 35–89; Type 2 diabetes	**Author-Stated Funding Source:** National Institute for Health Research.

Systematic Review **Citation:** Bhurji N, Javer J, Gasevic D, Khan NA. Improving management of type 2 diabetes in South Asian patients: a systematic review of intervention studies. *BMJ Open*. 2016;6(4):e008986. doi:10.1136/bmjopen-2015-008986.	
Purpose: To evaluate the effect of diabetes management interventions targeted at South Asian patients with type 2 diabetes on glycemic control. **Timeframe:** January 1990–February 2014 **Total # of Studies:** 23 (4 exercise, 4 yoga) **Exposure Definition:** Exercise mode included walking, progressive resistance training, and yoga. Frequency, intensity, time, and duration of program varied. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Disease progression: Hemoglobin A1c, fasting blood glucose, blood pressure, weight, body mass index, waist circumference, and lipid levels. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** OBJECTIVES: Optimal control of type 2 diabetes is challenging in many patient populations including in South Asian patients. We systematically reviewed studies on the effect of diabetes management interventions targeted at South Asian patients with type 2 diabetes on glycaemic control. DESIGN: Systematic review of MEDLINE, EMBASE and CINAHL databases for randomised controlled trials (RCTs) and pre-post-test studies (January 1990 to February 2014). Studies were stratified by where interventions were conducted (South Asia vs Western countries). PARTICIPANTS: Patients originating from Pakistan, Bangladesh or India with type 2 diabetes. PRIMARY OUTCOME: Change in glycated haemoglobin (HbA1c). Secondary end points included change in blood pressure, lipid levels, anthropomorphics and knowledge. RESULTS: 23 studies (15 RCTs) met criteria for analysis with 7 from Western countries (n=2532) and 16 from South Asia (n=1081). Interventions in Western countries included translated diabetes education, additional clinical care, written materials, visual aids, and bilingual community-based peers and/or health professionals. Interventions conducted in South Asia included yoga, meditation or exercise, community-based peers, health professionals and dietary education (cooking exercises). Among RCTs in India (5 trials; n=390), 4 demonstrated significant reductions in HbA1c in the intervention group compared with usual care (yoga and exercise interventions). Among the 4 RCTs conducted in Europe (n=2161), only 1 study, an education intervention of 113 patients, reported a significant reduction in HbA1c with the intervention. Lipids, blood pressure and knowledge improved in both groups with studies from India more often reporting reductions in body mass index and waist circumference. CONCLUSIONS: Overall, there was little improvement in HbA1c level in diabetes management interventions targeted at South Asians living in Europe compared with usual care, although other outcomes did improve. The smaller studies in India demonstrated significant improvements in glycaemic and other end points. Novel strategies are needed to improve glycaemic control in South Asians living outside of India.
Populations Analyzed: Adults 35–66; South Asian (India, Pakistan, Bangladesh); Type 2 diabetes	**Author-Stated Funding Source:** Michael Smith Foundation.

<table>
<tr><td colspan="2">Systematic Review
Citation: Byrne H, Caulfield B, De Vito G. Effects of self-directed exercise programmes on individuals with type 2 diabetes mellitus: a systematic review evaluating their effect on HbA1c and other metabolic outcomes, physical characteristics, cardiorespiratory fitness and functional outcomes. Sports Med. 2017;47(4):717-733. doi:10.1007/s40279-016-0593-y.</td></tr>
<tr><td>Purpose: To examine the effects of planned self-directed exercise on glycosylated hemoglobin and other outcomes in individuals with type 2 diabetes, and to identify the most suitable forms of planned self-directed exercise for individuals with type 2 diabetes that can be carried out independently.</td><td rowspan="5">Abstract: BACKGROUND: Type two diabetes mellitus (T2DM) is caused and progressed by an individual's lifestyle and, therefore, its optimal day-to-day management may involve the patient taking responsibility for this, including fulfilling a planned and prescribed exercise regime used as part of the treatment. A prescription of exercise designed to meet a patient's individual needs with minimal supervision from healthcare practitioners would facilitate this. However, the optimal prescription of exercise in the population remains unclear. OBJECTIVE: This review examines the effects planned self-directed exercise has on glycosylated haemoglobin and other outcomes in individuals with T2DM and aims to identify the most suitable forms of planned self-directed exercise for individuals with T2DM that can be carried out independently. METHODS: A search of the electronic databases PubMed, SPORTDiscus, CINAHL, EMBASE, Cochrane (Trials) and ClinicalTrials.gov was conducted along with reference lists of previous reviews. Randomised controlled trials published in English between January 1990 and February 2015 examining participants diagnosed with T2DM only were included. Studies were critically appraised using the PEDro (Physiotherapy Evidence Database) scale and data were presented on standardised tables. RESULTS: Twenty-eight articles that used five element gymnastics, a games console exercise intervention (Wii fit plus) or aerobic, resistance or combined training were included. CONCLUSION: This review comprehensively summarised the effects planned self-directed exercise interventions had on individuals with T2DM. The review found that self-directed exercise was found to be beneficial for individuals with T2DM for improving glycosylated haemoglobin, physical characteristics, cardiorespiratory fitness, functional measures and other metabolic outcomes.</td></tr>
<tr><td>Timeframe: January 1990–February 2015</td></tr>
<tr><td>Total # of Studies: 28</td></tr>
<tr><td>Exposure Definition: Mode of exercise included aerobic, resistance, combined aerobic and resistance, five-element gymnastics, and a games console (Wii fit). Program duration was between 4 weeks and 14 months. Sessions of exercise varied in frequency and time. All programs were self directed.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Hemoglobin A1c; Blood lipids (high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, triglycerides, and cholesterol); Blood pressure (systolic and diastolic); Body mass index, weight; waist circumference, VO2 max, and lower body strength.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Type 2 diabetes</td><td>Author-Stated Funding Source: Science Foundation Ireland; Insight Centre for Data Analytics.</td></tr>
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<tr><td colspan="2">Systematic Review
Citation: Cai H, Li G, Zhang P, Xu D, Chen L. Effect of exercise on the quality of life in type 2 diabetes mellitus: a systematic review. Qual Life Res. 2017;26(3):515-530. doi:10.1007/s11136-016-1481-5.</td></tr>
<tr><td>Purpose: To examine the effect of exercise on quality of life for people with type 2 diabetes and gain greater insight into the role of exercise training in people with type 2 diabetes.</td><td rowspan="5">Abstract: PURPOSE: Diabetic patients tend to have a poor quality of life. A sedentary lifestyle is considered to be a modifiable risk factor for type 2 diabetes and an independent predictor of poor quality of life. Exercise is a key treatment for people living with diabetes. The purpose of this study was to conduct a systematic review to assess the effect of exercise on the quality of life of people with type 2 diabetes. METHODS: We conducted a systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. PubMed, Web of Science, Embase, Cochrane Library, CINAHL and three Chinese databases were searched for studies published until January 2016. The review included all clinical trials that evaluated the effect of exercise on quality of life compared with that of usual care for people with type 2 diabetes. Two reviewers independently assessed the quality of all the included studies, by using the Downs and Black Quality Index (QI). RESULTS: Thirty studies met inclusion criteria, with 2785 participants. We divided the exercise into four modes: aerobic, resistance, a combination of aerobic and resistance and yoga. Aerobic exercise showed a significant effect between groups. Resistance and combined exercise showed mixed results. Yoga also showed good intervention effects on quality of life. CONCLUSIONS: The effect of aerobic exercise on the quality of life in people with type 2 diabetes was safe and effective. Then, most of the studies on aerobic exercise were of good methodological quality. The effects of resistance exercise and combined exercise on the quality of life in people with type 2 diabetes were mixed, and the effect of yoga on quality of life still need more research.</td></tr>
<tr><td>Timeframe: Inception–2016</td></tr>
<tr><td>Total # of Studies: 30</td></tr>
<tr><td>Exposure Definition: Exercise program modes were mainly aerobic training (treadmills and bicycling), resistance training (resistance training machines), yoga, or a combination of aerobic and resistance training. Exercise sessions varied from 10 to 75 minutes. The frequency of the training sessions varied from 1 to 7 times per week. Programs lasted from 5 weeks to 12 months.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Quality of life: World Health Organization Quality of Life questionnaire, Short Form Health Survey, Short Form 36, Swedish Health Related Quality Of Life Questionnaire, Quality of Life and Dietetics Questionnaire, Allgemeine Depressionsskala, and neuropathy quality of life.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults ≥ 18 years; Type 2 diabetes</td><td>Author-Stated Funding Source: Youth Program of Health and Family Planning Commission of Jilin Province.</td></tr>
</table>

Meta-Analysis **Citation:** Chudyk A, Petrella RJ. Effects of exercise on cardiovascular risk factors in type 2 diabetes: a meta-analysis. *Diabetes Care*. 2011;34(5):1228-1237. doi:10.2337/dc10-1881.	
Purpose: To investigate the effects of aerobic exercise, resistance training (RT), and combined aerobic and resistance training on cardiovascular risk factors in people with type 2 diabetes. **Timeframe:** 1970–October 2009 **Total # of Studies:** 34 **Exposure Definition:** Exercise programs consisting of either aerobic (walking, bicycle, rowing, or swimming) or progressive resistance training or a combined program. The frequency of prescribed exercise ranged from a minimum of 1 to a maximum of 7 sessions per week. The length of the exercise sessions ranged between 40 and 75 minutes, and the duration of exercise interventions ranged between 2 months and 1 year. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Cardiovascular risk factors: hemoglobin A1c (%). Dyslipidemia: high-density lipoprotein cholesterol, low-density lipoprotein cholesterol. Body composition: body mass index (kg/m2), waist circumference (cm), weight (kg). Systolic blood pressure (mmHg). **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** OBJECTIVE: Exercise is a cornerstone of diabetes management and the prevention of incident diabetes. However, the impact of the mode of exercise on cardiovascular (CV) risk factors in type 2 diabetes is unclear. RESEARCH DESIGN AND METHODS: We conducted a systematic review of the literature between 1970 and October 2009 in representative databases for the effect of aerobic or resistance exercise training on clinical markers of CV risk, including glycemic control, dyslipidemia, blood pressure, and body composition in patients with type 2 diabetes. RESULTS: Of 645 articles retrieved, 34 met our inclusion criteria; most investigated aerobic exercise alone, and 10 reported combined exercise training. Aerobic alone or combined with resistance training (RT) significantly improved HbA(1c) -0.6 and -0.67%, respectively (95% CI -0.98 to -0.27 and -0.93 to -0.40, respectively), systolic blood pressure (SBP) -6.08 and -3.59 mmHg, respectively (95% CI -10.79 to -1.36 and -6.93 to -0.24, respectively), and triglycerides -0.3 mmol/L (95% CI -0.48 to -0.11 and -0.57 to -0.02, respectively). Waist circumference was significantly improved -3.1 cm (95% CI -10.3 to -1.2) with combined aerobic and resistance exercise, although fewer studies and more heterogeneity of the responses were observed in the latter two markers. Resistance exercise alone or combined with any other form of exercise was not found to have any significant effect on CV markers. CONCLUSIONS: Aerobic exercise alone or combined with RT improves glycemic control, SBP, triglycerides, and waist circumference. The impact of resistance exercise alone on CV risk markers in type 2 diabetes remains unclear.
Populations Analyzed: Adults ≥18; Type 2 diabetes	**Author-Stated Funding Source:** Not reported.

Meta-Analysis **Citation:** Cui J, Yan JH, Yan LM, Pan L, Le JJ, Guo YZ. Effects of yoga in adults with type 2 diabetes mellitus: a meta-analysis. *J Diabetes Investig*. 2017;8(2):201-209. doi:10.1111/jdi.12548.	
Purpose: To determine the effectiveness of yoga in patients with type 2 diabetes mellitus.	**Abstract:** AIMS/INTRODUCTION: A meta-analysis was carried out to evaluate the efficacy of yoga in adults with type 2 diabetes mellitus. MATERIALS AND METHODS: The PubMed, EMBASE and Cochrane databases were searched to obtain eligible randomized controlled trials. The primary outcome was fasting blood glucose, and the secondary outcomes included glycosylated hemoglobin A1c, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, triglyceride and postprandial blood glucose. Weighted mean differences and 95% confidence intervals (CIs) were calculated. The I2 statistic represented heterogeneity. RESULTS: A total of 12 randomized controlled trials with a total of 864 patients met the inclusion criteria. The pooled weighted mean differences were -23.72 mg/dL (95% CI -37.78 to -9.65; P = 0.001; I2 = 82%) for fasting blood glucose and -0.47% (95% CI -0.87 to -0.07; P = 0.02; I2 = 82%) for hemoglobin A1c. The weighted mean differences were -17.38 mg/dL (95% CI -27.88 to -6.89; P = 0.001; I2 = 0%) for postprandial blood glucose, -18.50 mg/dL (95% CI -29.88 to -7.11; P = 0.001; I2 = 75%) for total cholesterol, 4.30 mg/dL (95% CI 3.25 to 5.36; P < 0.00001; I2 = 10%) for high-density lipoprotein cholesterol, -12.95 mg/dL (95% CI -18.84 to -7.06; P < 0.0001; I2 = 37%) for low-density lipoprotein cholesterol and -12.57 mg/dL (95% CI -29.91 to 4.76; P = 0.16; I2 = 48%) for triglycerides. CONCLUSIONS: The available evidence suggests that yoga benefits adult patients with type 2 diabetes mellitus. However, considering the limited methodology and the potential heterogeneity, further studies are necessary to support our findings and investigate the long-term effects of yoga in type 2 diabetes mellitus patients.
Timeframe: Inception–April 2016	
Total # of Studies: 12	
Exposure Definition: Exercise programs that focused on the practice of yoga were included. The frequency, duration, amount of time, and intensity varied by study. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No	
Outcomes Addressed: Indices of disease progression: fasting blood glucose, hemoglobin A1c, postprandial blood glucose, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, and triglyceride. **Examine Cardiorespiratory Fitness as Outcome:** No	
Populations Analyzed: Adults; Type 2 diabetes	**Author-Stated Funding Source:** Not reported.

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Figueira FR, Umpierre D, Cureau FV, et al. Association between physical activity advice only or structured exercise training with blood pressure levels in patients with type 2 diabetes: a systematic review and meta-analysis. Sports Med. 2014;44(11):1557-1572. doi:10.1007/s40279-014-0226-2.</td></tr>
<tr><td>Purpose: To compare the effects of structured exercise training (aerobic, resistance, or a combination of aerobic and resistance training) and PA advice only on changes in blood pressure in patients with type 2 diabetes.
Timeframe: January 1980–May 2013
Total # of Studies: 30
Exposure Definition: Structured exercise training, which included aerobic, resistance, or a combination of both trainings, ranging from 2 to 4 sessions/week for 30–60 minutes/session.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No
Outcomes Addressed: Absolute changes in systolic blood pressure and diastolic blood pressure.
Examine Cardiorespiratory Fitness as Outcome: No</td><td>Abstract: BACKGROUND: Diabetes is associated with marked cardiovascular morbidity and mortality. However, the association between different types of exercise training and blood pressure (BP) changes is not fully clear in type 2 diabetes. OBJECTIVE: The aim of this systematic review and meta-analysis of randomized controlled clinical trials (RCTs) was to determine the effects of structured exercise training (aerobic [AER], resistance [RES], or combined [COMB]) and physical activity (PA) advice only on BP changes in patients with type 2 diabetes. METHODS: Searches in five electronic databases were conducted to retrieve studies published from 1980 to 2013. Eligible studies were RCTs consisting of structured exercise training or PA advice versus no intervention in patients with type 2 diabetes. We used random effect models to derive weighted mean differences (WMDs) of exercises on absolute changes in systolic BP (SBP) and diastolic BP (DBP). RESULTS: A total of 30 RCTs of structured training (2,217 patients) and 21 of PA advice (7,323 patients) were included. Data were extracted independently in duplicate. Structured exercise was associated with reductions in SBP (WMD -4.22 mmHg; 95% confidence interval [CI] -5.89 to -2.56) and DBP (WMD -2.07 mmHg; 95% CI -3.03 to -1.11) versus controls. In structured exercise interventions, AER and RES were associated with declines in BP, and COMB was not associated with BP changes. However, in sensitivity analysis, a high-intensity protocol within COMB was associated with declines in SBP (WMD -3.30 mmHg; 95% CI -4.71 to -1.89). Structured exercise longer than 150 min/week was associated with greater BP reductions. PA advice only was associated with reduction in SBP (WMD -2.97 mmHg; 95% CI -4.52 to -1.43) and DBP (WMD -1.41 mmHg; 95% CI -1.94 to -0.88) versus controls. CONCLUSIONS: AER, RES, and high-intensity combined training are associated with BP reduction in patients with type 2 diabetes, especially in exercise programs lasting more than 150 min/week. PA advice only is also associated with lower BP levels.</td></tr>
<tr><td>Populations Analyzed: Adults ≥18; Type 2 diabetes</td><td>Author-Stated Funding Source: Fundo de Incentivo à Pesquisa do HCPA; Conselho Nacional de Desenvolvimento Científico e Tecnológico; Coordenaçaõ de Aperfeiçoamento de Pessoal de Nível Superior.</td></tr>
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<tr><td colspan="2">Systematic Review
Citation: Freire MD, Alves C. Therapeutic Chinese exercises (Qigong) in the treatment of type 2 diabetes mellitus: a systematic review. Diabetes Metab Syndr. 2013;7(1):56-59. doi:10.1016/j.dsx.2013.02.009.</td></tr>
<tr><td>Purpose: To provide a systematic review of the effects of qigong as a co-adjuvant therapy for type 2 diabetes.
Timeframe: January 1992–December 2010
Total # of Studies: 5
Exposure Definition: Qigong: type of Chinese exercise that combines meditation, movement, and breath control in one single practice. The exercise varied in duration and frequency.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No
Outcomes Addressed: Fasting blood glucose. Hemoglobin A1c. Insulin resistance. C-peptide.
Examine Cardiorespiratory Fitness as Outcome: No</td><td>Abstract: STATEMENT OF THE PROBLEM: Complementary and alternative medicines have been increasingly used as a co adjuvant treatment of chronic diseases, including diabetes mellitus. However, very little is known, especially in western countries, about its effects in the treatment of type 2 diabetes mellitus (T2DM). The purpose of this review was to summarize and critically evaluate clinical evidences regarding the effect of Chinese therapeutic exercises (Qigong) in the treatment of T2DM. METHODS: A systematic literature review, from January 1992 up to July 2011, searched articles indexed in the MEDLINE, LILACS and QIGONG databases, published in English and Portuguese. Terms combined in a Boolean search were "Qigong", "Chikung" "qi-gong" "diabetes" and "glycemic control". Risk of bias was assessed using the Cochrane criteria. RESULTS: Out of 30 English written articles, 5 studies met the inclusion criteria. Their results suggested favorable effects of Qigong in reducing C-peptide and fasting blood glucose levels in addition of improving insulin resistance and glycosilated hemoglobin. CONCLUSIONS: The few studies, written in English, available on this subject had a somewhat limited methodological quality preventing definitive conclusions about the efficacy of Qigong Chinese exercises in the treatment of type 2 diabetes mellitus. There is a need of large randomized clinical trials to prove the effectiveness of this modality of therapy, as well as the need for more research papers written in English in order to disseminate and expand the potential benefit of this therapy in the management of T2DM.</td></tr>
<tr><td>Populations Analyzed: Type 2 diabetes</td><td>Author-Stated Funding Source: Not reported.</td></tr>
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<table>
<tr><td colspan="2">Systematic Review
Citation: Funk M, Taylor EL. Pedometer-based walking interventions for free-living adults with type 2 diabetes: a systematic review. Curr Diabetes Rev. 2013;9(6):462-471. doi:10.2174/15733998113096660084.</td></tr>
<tr><td>Purpose: To determine the effect of pedometer-based interventions on PA and health outcomes in patients with type 2 diabetes.</td><td rowspan="5">Abstract: Physical activity (PA) is prescribed as an important method of treatment for type 2 diabetes (T2DM), but is neglected in a majority of patients. Walking is an appropriate and safe form of PA which improves glucose utilization in inactive people diagnosed with T2DM. Pedometers have been successfully used to motivate and track progress in many types of walking programs, but there is no current review of their effectiveness compared to other methods to increase PA in people with T2DM. A systematic literature review was performed using MEDLINE, CINAHL, SPORTDiscus, ERIC, and Academic Search Premier to determine the effectiveness of pedometer-based walking interventions at increasing PA in free-living adults with T2DM. Ten studies from 2004 to 2011 were included. All studies were randomized controlled trials except for one quasi-experimental design. Interventions lasted from 6 weeks to 6 months and only 2 studies showed significant improvements in blood glucose control following the intervention. Nine of the ten interventions were able to produce an increase in PA using a pedometer and/or other methods. Pedometers are effective means of increasing PA among T2DM patients in the short-term while several other intervention methods beyond normal treatment are also successful. Future research should include longer intervention durations, low cost methods, larger sample sizes, and dietary intervention components to further understand successful intervention techniques for patients with T2DM.</td></tr>
<tr><td>Timeframe: 2004–2011</td></tr>
<tr><td>Total # of Studies: 10</td></tr>
<tr><td>Exposure Definition: Pedometer-based PA interventions ranging from 6 weeks to 6 months.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Glycemic outcomes such as hemoglobin A1c, fasting glucose, and insulin.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults 18–89; Type 2 diabetes</td><td>Author-Stated Funding Source: Not reported.</td></tr>
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<table>
<tr><td colspan="2">Meta-Analysis
Citation: Grace A, Chan E, Giallauria F, Graham PL, Smart NA. Clinical outcomes and glycaemic responses to different aerobic exercise training intensities in type II diabetes: a systematic review and meta-analysis. Cardiovasc Diabetol. 2017;16(1):37. doi:10.1186/s12933-017-0518-6.</td></tr>
<tr><td>Purpose: To establish whether aerobic exercise training is associated with beneficial effects on clinical outcomes and glycemic profile in people with type 2 diabetes.</td><td rowspan="5">Abstract: AIMS: To establish if aerobic exercise training is associated with beneficial effects on clinical outcomes and glycaemic profile in people with type II diabetes. METHODS: A systematic search was conducted to identify studies through a search of MEDLINE (1985 to Sept 1, 2016, Cochrane Controlled Trials Registry (1966 to Sept 1, 2016), CINAHL, SPORTDiscus and Science Citation Index. The search strategy included a mix of MeSH and free text terms for related key concepts. Searches were limited to prospective randomized or controlled trials of aerobic exercise training in humans with type II diabetes, aged >18 years, lasting >2 weeks. RESULTS: Our analysis included 27 studies (38 intervention groups) totalling 1372 participants, 737 exercise and 635 from control groups. The studies contain data from 39,435 patient-hours of exercise training. Our analyses showed improvements with exercise in glycosylated haemoglobin (HbA1C%) MD: -0.71%, 95% CI -1.11, -0.31; p value = 0.0005. There were significant moderator effects; for every additional week of exercise HbA1C% reduces between 0.009 and 0.04%, p = 0.002. For those exercising at vigorous intensity peak oxygen consumption (peak VO2) increased a further 0.64 and 5.98 ml/kg/min compared to those doing low or moderate intensity activity. Homeostatic model assessment of insulin resistance (HOMA-IR) was also improved with exercise MD: -1.02, 95% CI -1.77, -0.28; p value = 0.007; as was fasting serum glucose MD: -12.53 mmol/l, 95% CI -18.94, -6.23; p value <0.0001; and serum MD: -10.39 IU, 95% CI -17.25, -3.53; p value = 0.003. CONCLUSIONS: Our analysis support existing guidelines that for those who can tolerate it, exercise at higher intensity may offer superior fitness benefits and longer program duration will optimize reductions in HbA1C%.</td></tr>
<tr><td>Timeframe: Inception–2016</td></tr>
<tr><td>Total # of Studies: 27</td></tr>
<tr><td>Exposure Definition: Supervised or unsupervised aerobic exercise interventions lasting at least 6 weeks. Intervention duration ranged from 4 to 52 weeks (average 17.8 weeks), with 2–5 weekly exercise sessions (median = 3). Session duration ranged from 15 to 75 minutes (median = 50 minutes), and mean weekly exercise time was 40–300 minutes (mean 157 minutes).
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Percentage change in hemoglobin A1c, Homeostatic model assessment of insulin resistance, lean body mass, BMI, body composition, peak VO2, fasting glucose, and insulin.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Adults >18; Type 2 diabetes</td><td>Author-Stated Funding Source: No funding source used.</td></tr>
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Systematic Review	
Citation: Gu Y, Dennis SM. Are falls prevention programs effective at reducing the risk factors for falls in people with type-2 diabetes mellitus and peripheral neuropathy: a systematic review with narrative synthesis. *J Diabetes Complications*. 2017;31(2):504-516. doi:10.1016/j.jdiacomp.2016.10.004.	
Purpose: To determine whether falls prevention exercises improve the muscle strength and balance of people with type 2 diabetes and diabetic peripheral neuropathy and reduce their risk of falls. **Timeframe:** Inception–April 2016 **Total # of Studies:** 10 **Exposure Definition:** Exercise included lower limb strengthening exercises (either weight bearing or non-weight bearing), balance exercises, walking programs, and tai chi. Programs varied in frequency, intensity, time, and duration. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Physical functioning: balance test, number of falls, lower limb muscle strength, 6-minute walk test, or Timed Up and Go test. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** BACKGROUND: Diabetic peripheral neuropathy (DPN) is a common complication of type-2 diabetes mellitus (T2DM) that predisposes the elderly to a higher falls risk. Falls prevention programs with a component of weight-bearing exercises are effective in decreasing future falls in the elderly. However, weight-bearing exercise was only recently recommended in guidelines for exercise for people with T2DM and DPN. Since then, there have been an increasing number of studies to evaluate the effectiveness of falls prevention programs on this targeted population. OBJECTIVES: A systematic literature review was undertaken to determine the effectiveness of falls prevention programs for people with T2DM and DPN. MAJOR FINDINGS: Nine published studies that investigated the effect of exercise training on falls risk among people with T2DM and DPN were included in the review. Interventions included lower limb strengthening, balance practice, aerobic exercise, walking programs, and Tai Chi. CONCLUSIONS: The preliminary evidence presented in this review suggests that people with T2DM and DPN can improve their balance and walking after a targeted multicomponent program without risk of serious adverse events. There is insufficient long-term follow-up data to determine whether the improvements in balance or strength resulted in a decrease falls risk in the community setting.
Populations Analyzed: Adults; Peripheral neuropathy; Type 2 diabetes	**Author-Stated Funding Source:** Not reported.

Meta-Analysis

Citation: Hayashino Y, Jackson JL, Fukumori N, Nakamura F, Fukuhara S. Effects of supervised exercise on lipid profiles and blood pressure control in people with type 2 diabetes mellitus: a meta-analysis of randomized controlled trials. *Diabetes Res Clin Pract*. 2012;98(3):349-360. doi:10.1016/j.diabres.2012.10.004.

Purpose: To assess the effect of different types of exercise on lipid profiles and blood pressure control among adults with type 2 diabetes, and to explore the effect of different types of exercise on hemoglobin A1c.	**Abstract:** AIMS: Our study's purpose was to perform a systematic review to assess the effect of supervised exercise interventions on lipid profiles and blood pressure control. METHODS: We searched electronic databases and selected studies that evaluated the effect of supervised exercise intervention on cardiovascular risk factors in adult people with type 2 diabetes. We used random effect models to derive weighted mean differences of exercise on lipid profiles and blood pressure control. RESULTS: Forty-two RCTs (2808 subjects) met inclusion criteria and are included in our meta-analysis. Structured exercise was associated with a change in systolic blood pressure (SBP) of -2.42 mmHg (95% CI, -4.39 to -0.45 mmHg), diastolic blood pressure (DBP) of -2.23 mmHg (95% CI, -3.21 to -1.25 mmHg), high-density lipoprotein cholesterol (HDL-C) of 0.04 mmol/L (95% CI, 0.02-0.07 mmol/L), and low-density lipoprotein cholesterol (LDL-C) of -0.16 mmol/L (95% CI, -0.30 to -0.01 mmol/L). Heterogeneity was partially explained by age, dietary co-intervention and the duration and intensity of the exercise. CONCLUSIONS: Supervised exercise is effective in improving blood pressure control, lowering LDL-C, and elevating HDL-C levels in people with diabetes. Physicians should recommend exercise for their adult patients with diabetes who can safely do so.
Timeframe: Inception–August 2012	
Total # of Studies: 42	
Exposure Definition: Three forms of exercise were studied: aerobic exercise, resistance exercise, and a combination of the two, lasting at least 8 weeks. Activities were used to estimate intensity (metabolic equivalents [METs]), and volume was calculated by multiplying the METs by total time spent exercising. Trials averaged 22.5 weeks in duration (range 8–108), and 292 METS in intensity (range 43–1,296). **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No	
Outcomes Addressed: Systolic and diastolic blood pressure. Lipid profile (total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglyceride), hemoglobin A1c, body-mass index, body weight, and waist circumference. **Examine Cardiorespiratory Fitness as Outcome:** No	
Populations Analyzed: Mean age 56.7; Type 2 diabetes	**Author-Stated Funding Source:** No funding source used.

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Hovanec N, Sawant A, Overend TJ, Petrella RJ, Vandervoort AA. Resistance training and older adults with type 2 diabetes mellitus: strength of the evidence. J Aging Res. Sept 2012:284635. doi:10.1155/2012/284635.</td></tr>
<tr><td>Purpose: To assess the effect of resistance training on metabolic, neuromuscular, and cardiovascular functions in older adults with type 2 diabetes.</td><td rowspan="5">Abstract: Objective. This paper analyzes the effects of resistance training (RT) on metabolic, neuromuscular, and cardiovascular functions in older adults (mean age >/= 65 years) with type 2 diabetes (T2DM). Research Design and Methods. A systematic review conducted by two reviewers of the published literature produced 3 records based on 2 randomized controlled trials that assessed the effect of RT on disease process measures and musculoskeletal/body composition measures. Statistical, Comprehensive Meta-Analysis (version 2) software was used to compute Hedge's g, and results were calculated using the random effects model to account for methodological differences amongst studies. Results. Largest effect of RT was seen on muscle strength; especially lower body strength, while the point estimate effect on body composition was small and not statistically significant. The cumulative point estimate for the T2DM disease process measures was moderate and statistically significant. Conclusions. RT generally had a positive effect on musculoskeletal, body composition, and T2DM disease processes measures, with tentative conclusions based on a low number of completed RCTs. Thus, more research is needed on such programs for older adults (>/=65 years) with T2DM.</td></tr>
<tr><td>Timeframe: Inception–August 2011</td></tr>
<tr><td>Total # of Studies: 3</td></tr>
<tr><td>Exposure Definition: Resistance training (RT) intervention or combination of RT and other forms of intervention (e.g., flexibility, weight loss, standard care).
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Body composition: whole body lean tissue mass, whole body fat mass. Type 2 diabetes process: fasting glucose, glycosylated hemoglobin (hemoglobin A1c), blood pressure, serum/fasting insulin, lipids (total cholesterol, high-density lipoprotein cholesterol, triglycerides, free fatty acids).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Mean age ≥65; Type 2 diabetes</td><td>Author-Stated Funding Source: Not reported.</td></tr>
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Meta-Analysis **Citation:** Huang XL, Pan JH, Chen D, Chen J, Chen F, Hu TT. Efficacy of lifestyle interventions in patients with type 2 diabetes: a systematic review and meta-analysis. *Eur J Intern Med*. 2016;27:37-47. doi:10.1016/j.ejim.2015.11.016.	
Purpose: To compare the outcomes of intensive exercise, dietary regimens, and comprehensive lifestyle interventions and its significance on clinical markers of cardiovascular disease in patients with type 2 diabetes. **Timeframe:** Inception–July 2014 **Total # of Studies:** 17 (5 only addressing PA exposure) **Exposure Definition:** Supervised intensive PA programs consisting of regular, structured, and personalized exercise prescription. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Reduction in the risk factors for cardiovascular disease, such as body mass index, hemoglobin A1c, blood pressure (systolic and diastolic blood pressure), and the level of cholesterol (high-density lipoprotein cholesterol, low-density lipoprotein cholesterol). **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** BACKGROUND: The current meta-analysis evaluated the outcomes of various lifestyle interventions, including diet modifications (DIET), physical activity (PA), and patient education (EDU) in reducing the risk of cardiovascular disease in patients with type 2 diabetes. METHODS: Randomized clinical trials comparing lifestyle intervention with "usual care" (control) in type 2 diabetes patients were hand-searched from medical databases by two independent reviewers using the terms "diabetes, cardiovascular risk, lifestyle, health education, dietary, exercise/physical activities, and behavior intervention". RESULTS: Of the 235 studies identified, 17 were chosen for the meta-analysis. The average age of patients ranged from 50-67.3 years. Results reveal no significant difference between the groups, with respect to BMI, while PA and DIET yielded a greater reduction in HbA1c. Significant reduction in both systolic and diastolic pressures in the DIET group, and diastolic pressure in the PA group, was observed. HDL-c in the DIET group was significantly higher than the control group, while no change in LDL-c levels, was seen in all three intervention subtypes. There was no difference between the EDU vs. the control group in terms of HbA1c, blood pressure or HDL-c and LDL-c. CONCLUSION: DIET intervention showed an improvement in HbA1c, systolic/diastolic blood pressure and HDL-c, with an exception of LDL-c and BMI, suggesting that nutritional intervention had a significant impact on the quality of life by reducing the cardiovascular risk in type 2 diabetes patients.
Populations Analyzed: Adults 50–67.3; Type 2 diabetes	**Author-Stated Funding Source:** Not reported.

Systematic Review **Citation:** Innes KE, Selfe TK. Yoga for adults with type 2 diabetes: a systematic review of controlled trials. *J Diabetes Res*. Dec 2016:6979370. doi:10.1155/2016/6979370.	
Purpose: To evaluate available evidence from controlled trials regarding the effects of yoga-based programs on health-related outcomes in adults with type 2 diabetes and to discuss possible mechanisms that may underlie observed benefits. **Timeframe:** Inception–March 2015 **Total # of Studies:** 25 **Exposure Definition:** Yoga interventions ranged from 15 days to 12 months in duration, with a majority including at least 12 weeks of practice. Programs varied substantially in practice frequency, intensity, and content, including, for example, a 3-month Hatha yoga program in which participants attended 1–2 classes/week, a 90-day program of daily deep yoga relaxation practice (yoga nidra), a 6-month Sudarshan Kriya rhythmic breathing program, with classes once/week and daily home practice, and a 3- to 12-month comprehensive yoga program with practice 6 to 7 days/week. Most of the yoga programs incorporated active asanas or yoga poses. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Metabolic indices: measured by glucose tolerance (fasting blood glucose, postprandial glucose, and hemoglobin A1c), insulin resistance, and lipid profiles (total cholesterol, high-density lipoprotein, low-density lipoprotein, very low-density lipoprotein, and triglycerides). Anthropometric measures: measured by body weight and body composition (body mass index, waist-to-hip ratio). Hemodynamic indices: measured by blood pressure. Mood and sleep impairment: measured by quality of life surveys, psychological well-being, and prevalence of insomnia. Pulmonary function: forced expiratory volume, forced vital capacity, peak expiratory flow rate, and maximum voluntary ventilation. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** A growing body of evidence suggests yogic practices may benefit adults with type 2 diabetes (DM2). In this systematic review, we evaluate available evidence from prospective controlled trials regarding the effects of yoga-based programs on specific health outcomes pertinent to DM2 management. To identify qualifying studies, we searched nine databases and scanned bibliographies of relevant review papers and all identified articles. Controlled trials that did not target adults with diabetes, included only adults with type 1 diabetes, were under two-week duration, or did not include quantitative outcome data were excluded. Study quality was evaluated using the PEDro scale. Thirty-three papers reporting findings from 25 controlled trials (13 nonrandomized, 12 randomized) met our inclusion criteria (N = 2170 participants). Collectively, findings suggest that yogic practices may promote significant improvements in several indices of importance in DM2 management, including glycemic control, lipid levels, and body composition. More limited data suggest that yoga may also lower oxidative stress and blood pressure; enhance pulmonary and autonomic function, mood, sleep, and quality of life; and reduce medication use in adults with DM2. However, given the methodological limitations of existing studies, additional high-quality investigations are required to confirm and further elucidate the potential benefits of yoga programs in populations with DM2.
Populations Analyzed: Adults; Type 2 diabetes	**Author-Stated Funding Source:** National Center for Complementary and Alternative Medicine; West Virginia University.

Meta-Analysis

Citation: Ishiguro H, Kodama S, Horikawa C, et al. In search of the ideal resistance training program to improve glycemic control and its indication for patients with type 2 diabetes mellitus: a systematic review and meta-analysis. *Sports Med*. 2016;46(1):67-77. doi:10.1007/s40279-015-0379-7.

Purpose: To update information on the effect of resistance training (RT) on hemoglobin A1c levels among patients with type 2 diabetes, and to suggest the characteristics of an RT program that would maximize its effect and those patients who would especially benefit from RT through sensitivity analyses.

Timeframe: 1966–August 2014

Total # of Studies: 23

Exposure Definition: Resistance training, ranging from 5 to 48 weeks in duration, with 5–10 resistance training items, frequency of 2–5 sessions/week, and 45–81% of 1 repetition maximum (1RM). Stratified analysis by intervention period (≥12, <12 weeks), frequency (≥3 times/week,<3 times/week), number of items (≥9,<9), intensity (≥75%,<75% of 1RM), interval (≥1.5,1.5 minutes), total sets per bout (≥21,<21 sets), and total sets per week (≥60,<60).

Measures Steps: No

Measures Bouts: No

Examines HIIT: No

Abstract: BACKGROUND: Resistance training (RT) is effective for glycemic control in type 2 diabetes mellitus (T2DM) patients. However, the characteristics of an RT program that will maximize its effect and those of patients that will especially benefit from RT are unknown. OBJECTIVE: The objectives of this systematic review were to identify via a comprehensive meta-analysis the characteristics of an RT program for patients with T2DM that might increase the patients' improvement in glycemic control and the characteristics of patients that will benefit from RT. DATA SOURCES: Electronic-based literature searches of MEDLINE and EMBASE entries from 1 January 1966 to 25 August 2014 were conducted to identify clinical trials examining the effect of RT on glycemic control among patients with T2DM. Study keywords were text words and thesaurus terms related to RT and T2DM. STUDY SELECTION: Studies were included if they (1) were clinical trials consisting of two groups with and without RT exercise intervention; (2) had an intervention period of at least 5 weeks; (3) clarified that all patients had T2DM; and (4) reported or made it possible to estimate the effect size [i.e., change in glycosylated hemoglobin (HbA1c) in the RT group minus that in the control group] and its corresponding standard error. STUDY APPRAISAL AND SYNTHESIS METHODS: The effect size in each study was pooled with a random-effects model. Analyses were stratified by several key characteristics of the patients and RT exercise programs; meta-regression analysis was then used to detect a difference in the effect size among strata within each factor. Linear regression analyses were added by entering each of the following profiles: patients' baseline characteristics [mean baseline age, body mass index (BMI), and HbA1c levels] and exercise characteristics (total sets per week, total sets per bout of exercise, frequency, and intensity). RESULTS: There were 23 eligible studies comprising 954 patients with T2DM. The pooled effect size (95% confidence interval) was -0.34% (-0.53 to -0.16). A program with multiple sets (>/=21 vs. <21) per one RT bout was associated with a large effect size (P = 0.03); however, the linear correlation between the number of sets and effect size was not significant (P = 0.56). A larger effect size was observed in studies with participants with diabetes of a relatively short duration (<6 vs. >/=6 years; P = 0.04) or a high baseline HbA1c [>/=7.5% (58 mmol/mol) vs. <7.5 %; P = 0.01] while a smaller effect size was observed in studies with a particularly high mean baseline BMI value (>/=32 vs. <32 kg/m(2); P = 0.03). Linear regression analyses predicted that each increment of 1% in the baseline HbA1c would enlarge the effect size by 0.036%, while each increment of 1 kg/m2 in the baseline BMI decreased it by 0.070% in the range between 22.3 and 38.8 kg/m2. CONCLUSION: In terms of glycemic

Outcomes Addressed: Glycosylated hemoglobin A1c levels. **Examine Cardiorespiratory Fitness as Outcome:** No	control, RT could be recommended in the early stage of T2DM, especially for patients with relatively poor glycemic control. More benefit would be elicited in less obese patients within a limited range of the BMI. A substantial amount of exercise might be required to stimulate post-exercise glucose uptake, although the dose-dependency was not specifically clarified.
Populations Analyzed: Adults ≥55, <55; European and American countries vs. others; body mass index ≥32 vs. <32; Type 2 diabetes	**Author-Stated Funding Source:** Japan Society for the Promotion of Science.

Meta-Analysis **Citation:** Kodama S, Tanaka S, Heianza Y, et al. Association between physical activity and risk of all-cause mortality and cardiovascular disease in patients with diabetes: a meta-analysis. *Diabetes Care*. 2013;36(2):471-479. doi:10.2337/dc12-0783.	
Purpose: To clarify the relationship between habitual PA and future all-cause mortality or incident cardiovascular disease in patients with diabetes, focusing on the dose-response association. **Timeframe:** 1950–2011 **Total # of Studies:** 17 **Exposure Definition:** PA dose standardized using a common unit (metabolic equivalent hour [MET-h]), where 1 MET-h corresponds to energy expenditure while sitting at rest for 1 hour. PA was divided into low and high groups where point estimates were assigned by extracting the mean level of daily PA. When a study expressed PA as a specific activity (e.g., walking, gardening) and its duration, intensity was defined according to the globally used compendium of PAs by Ainsworth et al. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Relative risk of all-cause mortality. Relative risk of cardiovascular disease. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** OBJECTIVE: The association between habitual physical activity (PA) and lowered risk of all-cause mortality (ACM) and cardiovascular disease (CVD) has been suggested in patients with diabetes. This meta-analysis summarizes the risk reduction in relation to PA, focusing on clarifying dose-response associations. RESEARCH DESIGN AND METHODS: Electronic literature searches were conducted for cohort studies that examined relative risk (RR) of ACM or CVD in relation to PA in patients with diabetes. For the qualitative assessment, RR for the highest versus the lowest PA category in each study was pooled with a random-effects model. We added linear and spline regression analyses to assess the quantitative relationship between increases in PA and ACM and CVD risk. RESULTS: There were 17 eligible studies. Qualitatively, the highest PA category had a lower RR [95% CI] for ACM (0.61 [0.52-0.70]) and CVD (0.71 [0.60-0.84]) than the lowest PA category. The linear regression model indicated a high goodness of fit for the risk of ACM (adjusted R(2) = 0.44, P = 0.001) and CVD (adjusted R(2) = 0.51, P = 0.001), with the result that a 1 MET-h/day incrementally higher PA was associated with 9.5% (5.0-13.8%) and 7.9% (4.3-11.4%) reductions in ACM and CVD risk, respectively. The spline regression model was not significantly different from the linear model in goodness of fit (P = 0.14 for ACM risk; P = 0.60 for CVD risk). CONCLUSIONS: More PA was associated with a larger reduction in future ACM and CVD risk in patients with diabetes. Nevertheless, any amount of habitual PA was better than inactivity.
Populations Analyzed: Adults <60; Adults ≥60; Overweight (BMI: 25–29.9); Type 2 diabetes	**Author-Stated Funding Source:** Grant-in-Aid for Scientific Research and Postdoctoral Research Fellowship from Society for the Promotion of Science; Japan Cardiovascular Research Foundation; Ministry of Health, Labor, and Welfare, Japan

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Kumar V, Jagannathan A, Philip M, Thulasi A, Angadi P, Raghuram N. Role of yoga for patients with type II diabetes mellitus: a systematic review and meta-analysis. Complement Ther Med. 2016;25:104-112. doi:10.1016/j.ctim.2016.02.001.</td></tr>
<tr><td>Purpose: To evaluate and analyze the available data on efficacy of yoga in improving blood glucose parameters in people with diabetes.</td><td rowspan="5">Abstract: To understand the role and efficacy of yoga in the management of type 2 diabetes mellitus, this meta-analysis was conducted. Electronic data bases searched were PubMed/Medline, ProQuest, PsycINFO, IndMED, CENTRAL, Cochrane library, CamQuest and CamBase till December 17, 2014. Eligible outcomes were fasting blood sugar (FBS), post prandial blood sugar (PPBS) and glycosylated haemoglobin (HBA1C). Randomized controlled trials and controlled trials were eligible. Studies focussing only on relaxation or meditation or multimodal intervention were not included. A total of 17 RCTs were included for review. Data from research articles on patients, methods, interventions- control and results were extracted. Mean and standard deviations were utilized for calculating standardized mean difference with 95% confidence interval. Heterogeneity was assessed with the help of I(2) statistics. chi(2) was used to rule out the effects of heterogeneity due to chance alone. Beneficial effects of yoga as an add-on intervention to standard treatment in comparison to standard treatment were observed for FBS [Standardized Mean Difference (SMD) -1.40, 95%CI -1.90 to -0.90, p<0.00001]; PPBS [SMD -0.91, 95%CI -1.34 to -0.48, p<0.0001] as well as HBA1C [SMD -0.64, 95%CI -0.97 to -0.30, p<0.0002]. But risk of bias was overall high for included studies. With this available evidence, yoga can be considered as add-on intervention for management of diabetes.</td></tr>
<tr><td>Timeframe: Inception–2014</td></tr>
<tr><td>Total # of Studies: 17</td></tr>
<tr><td>Exposure Definition: Exercise mode for programs was yoga. Programs varied from 40 days to 6 months, and the frequency of classes varied from 1 to 7 days per week. Duration of sessions varied from 45 to 120 minutes, with many having a 60–90 minute duration.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Disease progression indices: fasting blood sugar, postprandial blood sugar, glycosylated hemoglobin, body mass index, waist hip ratio, systolic blood pressure, diastolic blood pressure, low-density lipoprotein, and fasting blood glucose. Quality of life.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults 30–75; Type 2 diabetes</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Lee J, Kim D, Kim C. Resistance training for glycemic control, muscular strength, and lean body mass in old type 2 diabetic patients: a meta-analysis. Diabetes Ther. 2017;8(3):459-473. doi:10.1007/s13300-017-0258-3.</td></tr>
<tr><td>Purpose: To quantify the effect of resistance training on hemoglobin A1c as well as muscular strength and lean body mass in elderly patients with type 2 diabetes.</td><td rowspan="5">Abstract: INTRODUCTION: Type 2 diabetes (T2D) in elderly patients is associated with accelerated loss of skeletal muscle mass and strength. However, there are few meta-analysis reviews which investigate the effects of resistance training (RT) on glycemic control and skeletal muscle in the patients. METHODS: Three electronic databases were searched (from the earliest date available to November 2016). Studies were included according to the inclusion criteria: T2D patients at least 60 years old, fasting plasma glucose of at least 7.0, and at least 8 weeks of RT. RESULTS: Fifteen cohorts of eight studies (360 patients, average age 66 years) met the inclusion criteria. RT groups lowered glycosylated hemoglobin (HbA1c) (mean ES = -0.37, 95% CI = -0.55 to -0.20, P < 0.01) but did not result in a significant effect on lean body mass (LBM) (mean ES = 0.08, 95% CI = -0.15 to 0.30, P = 0.50). Homogeneity was shown between studies regarding HbA1c and LBM (Q = 15.70, df = 9, P = 0.07 and Q = 0.12, df = 4, P = 0.998, respectively). High-intensity subgroups showed a slight tendency to improve (rather than duration, frequency, and weekly volume) and to decrease HbA1c levels more than low-intensity subgroups (P = 0.37). RT increased muscular strength (mean ES = 1.05, 95% CI = 0.26-1.84, P = 0.01). No training components explained the heterogeneity between studies with changes in muscle strength. CONCLUSION: RT improves glycemic control and muscle strength in elderly patients with T2D. RT with high intensity can be a strategy to treat patients with T2D and sarcopenia associated with aging.</td></tr>
<tr><td>Timeframe: Inception–November 2016</td></tr>
<tr><td>Total # of Studies: 8</td></tr>
<tr><td>Exposure Definition: Resistance training interventions lasting at least 8 weeks. The mean training period was 26 weeks, with a range of 12 minutes to 56 weeks. The mean session duration was 52 minutes, with a range of 45–60 minutes. Training consisted of 2–3 sets, 8–15 repetitions, and 5–10 exercises.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Hemoglobin A1c: mmol/mol (%) levels. Muscular strength: percent change in the 1-repetition maximum (1RM) or dynamometry. Muscle mass: lean body mass or skeletal muscle mass.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults ≥60; Type 2 diabetes</td><td>Author-Stated Funding Source: No funding source used.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Lee MS, Choi TY, Lim HJ, Ernst E. Tai chi for management of type 2 diabetes mellitus: a systematic review. Chin J Integr Med. 2011;17(10):789-793. doi:10.1007/s11655-011-0812-1.</td></tr>
<tr><td>Purpose: To summarize and critically evaluate ways to systematically assess the evidence from clinical trials of tai chi for treating diabetes mellitus.</td><td rowspan="5">Abstract: OBJECTIVE: Tai chi has been recommended for treating type 2 diabetes mellitus. The purpose of this systematic review was to evaluate evidence from controlled clinical trials testing the effectiveness of tai chi in treating type 2 diabetes mellitus. METHODS: Systematic searches were conducted on 14 electronic databases without restrictions on either population characteristics or language of publication. The outcome measures considered for inclusion were changes in fasting blood glucose (FBG), glycosylated haemoglobin A1c (HbA1c) and quality of life (QOL). RESULTS: Eight randomised clinical trials (RCTs) and two controlled clinical trials (CCTs) met all inclusion criteria. Three RCTs from 1 trial compared the effects of tai chi with sham exercise and failed to show effectiveness of tai chi on FBG, HbA1c, or QOL. The other 3 RCTs tested the effects of tai chi compared with other types of exercise on FBG. The meta-analysis failed to show an FBG-lowering effect of tai chi [n=118, weighted mean difference (WMD): -0.14 mmol/L, 95% CI: -0.86 to 0.58, P=0.70]. Four studies (2 RCTs and 2 CCT) compared tai chi with no treatment or self-management programme and failed to report significant differences between the experimental and control groups except for QOL from 1 RCT and 1 CCT. CONCLUSION: The existing evidence does not suggest that tai chi is an effective therapy for type 2 diabetes. Currently, there are few high-quality trials on which to make definitive judgements.</td></tr>
<tr><td>Timeframe: Inception–March 2011</td></tr>
<tr><td>Total # of Studies: 12</td></tr>
<tr><td>Exposure Definition: Tai chi, alone or combined with other treatments. Total number of sessions ranged from 20 to 168, with a frequency of 2–7 sessions/week and a duration of 30–60 minutes per session.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Fasting blood glucose. Insulin resistance. Hemoglobin A1c. Quality of life. Fasting plasma insulin.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Type 2 diabetes</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

Meta-Analysis **Citation:** Lee MS, Jun JH, Lim HJ, Lim HS. A systematic review and meta-analysis of tai chi for treating type 2 diabetes. *Maturitas*. 2015;80(1):14-23. doi:10.1016/j.maturitas.2014.09.008.	
Purpose: To update, complete, and critically evaluate the evidence from randomized control trials of tai chi as a treatment modality for patients with type 2 diabetes mellitus.	**Abstract:** The aim of this review was to update and critically evaluate the evidence from randomised clinical trials (RCTs) of tai chi for patients with type 2 diabetes mellitus (T2DM). Twelve databases were searched by August 2014. Fifteen RCTs met all of the inclusion criteria. One RCT compared the effects of tai chi with sham exercise and failed to show the effectiveness of tai chi on fasting blood glucose (FBG), or HbA1c. The other four RCTs tested the effects of tai chi compared with various types of exercise and the meta-analysis failed to show an FBG-lowering effect. Five RCTs compared the effects of tai chi with an anti-diabetic medication and the meta-analysis showed favourable effects of tai chi on FBG. One RCT showed the positive effects of tai chi plus standard care on HbA1c and FBG compared with standard care alone. Four RCTs compared the effects of tai chi to no treatment and the meta-analysis failed to show the positive effects of tai chi on HbA1c. Three RCTs reported superior effects of tai chi on quality of life. In conclusion, the existing trial evidence is not convincing enough to suggest that tai chi is effective for managing patients with T2DM.
Timeframe: Inception–August 2014	
Total # of Studies: 15 (12 for meta-analysis)	
Exposure Definition: Any style of tai chi. The number of sessions ranged from 24 to 336, with a frequency of 2 to 7 sessions weekly and a duration of 30–60 minutes per session. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No	
Outcomes Addressed: Glycemic control: measured by glycosylated hemoglobin (HbA1c) and fasting blood glucose. Quality of life. **Examine Cardiorespiratory Fitness as Outcome:** No	
Populations Analyzed: Adults ≥18; Type 2 diabetes	**Author-Stated Funding Source:** No external funding source used.

Meta-Analysis **Citation:** Liubaoerjijin Y, Terada T, Fletcher K, Boule NG. Effect of aerobic exercise intensity on glycemic control in type 2 diabetes: a meta-analysis of head-to-head randomized trials. *Acta Diabetol*. 2016;53(5):769-781. doi:10.1007/s00592-016-0870-0.	
Purpose: To directly compare exercise interventions of different intensities on hemoglobin A1c in type 2 diabetes. **Timeframe:** Inception–January 2016 **Total # of Studies:** 8 **Exposure Definition:** Structured aerobic exercise interventions of various intensities. Subgroup analysis compared high-intensity interval training, high-intensity continuous training, moderate-intensity continuous training, and low-intensity continuous training. The exercise programs lasted from 12 weeks to 6 months. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** Yes **Outcomes Addressed:** Hemoglobin A1c, fasting blood glucose, fasting insulin, and insulin resistance. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** AIMS: To conduct a meta-analysis of head-to-head trials comparing aerobic exercise training of different intensities on glycemic control in type 2 diabetes. METHODS: Databases, including MEDLINE and EMBASE, were searched up to January 2016. Randomized trials of at least 12 weeks in duration that compared two exercise interventions of different intensities were identified. Two reviewers independently extracted data from eligible trials. Using fixed effect model, weighted mean differences (WMD) between different exercise intensities were calculated for changes in glycated hemoglobin (HbA1c) and secondary outcomes, such as fasting glucose and fasting insulin. RESULTS: Eight studies with a total of 235 participants were eligible. The exercise interventions lasted from 12 weeks to 6 months. The prescribed exercise intensities varied among studies. Four studies utilized vigorous exercise intensities for short durations by performing interval training. Overall, higher-intensity exercise resulted in a greater reduction in HbA1c compared to lower-intensity exercise (WMD = -0.22 %; 95 % confidence interval [-0.38, -0.06]; or -2.4 mmol/mol [-4.15, -0.66], I (2) = 0). Adherence to exercise and proportion of dropouts did not differ within trials. No adverse events were reported in these small trials with selected inclusion criteria. CONCLUSIONS: Although our meta-analysis had a limited sample size, increasing exercise intensity safely accentuated reductions in HbA1c in some people with type 2 diabetes. Different approaches have been used to increase exercise intensity (i.e., some used interval training, whereas others used higher-intensity continuous exercise). However, at this time, it is unclear which form, if any, leads to the most favorable results.
Populations Analyzed: Adolescents; Adults; Type 2 Diabetes	**Author-Stated Funding Source:** University of Alberta.

Meta-Analysis **Citation:** McGinley SK, Armstrong MJ, Boule NG, Sigal RJ. Effects of exercise training using resistance bands on glycaemic control and strength in type 2 diabetes mellitus: a meta-analysis of randomised controlled trials. *Acta Diabetol*. 2015;52(2):221-230. doi:10.1007/s00592-014-0594-y.	
Purpose: To systematically review randomised controlled trials investigating the effects of exercise interventions using resistance band training on glycemic control (hemoglobin A1c) or strength in adults with type 2 diabetes. **Timeframe:** 1946–August 2013 **Total # of Studies:** 7 **Exposure Definition:** Exercise training using resistance bands. Frequency of sessions was 3–10 times/week with a warm-up and a cool-down. The mean duration of the resistance band training intervention was 13 weeks. For each intervention, there was between 7 and 11 exercises, 2–3 sets, and 8–20 repetitions. The prescribed intensity of the resistance band training was said to be based on a percentage of the one repetition maximum (1 RM) in 5 of the 7 included studies and ranged from 40 to 60% of the 1 RM. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Hemoglobin A1c **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** Resistance exercise using free weights or weight machines improves glycaemic control and strength in people with type 2 diabetes. Resistance band training is potentially less expensive and more accessible, but the effects of resistance band training on glycaemic control and strength in this population are not well understood. This paper aims to systematically review and meta-analyse the effect of resistance band training on haemoglobin A1c (HbA1c) and strength in adults with type 2 diabetes. Database searches were performed in August 2013 (MEDLINE, SPORTDiscus, EMBASE, and CINAHL). Reference lists of eligible articles were hand-searched for additional studies. Randomised trials evaluating the effects of resistance band training in adults with type 2 diabetes on HbA1c or objectively measured strength were selected. Baseline and post-intervention HbA1c and strength were extracted for the intervention and control groups. Details of the exercise interventions and methodological quality were collected. Seven trials met inclusion criteria. Post-intervention-weighted mean HbA1c was nonsignificantly lower in exercise groups compared to control groups [weighted mean difference (WMD) = -0.18 percentage points (-1.91 mmol/mol); $P = 0.27$]. Post-intervention strength was significantly higher in the exercise groups compared to the control groups in the lower extremities (WMD = 21.90 kg; $P < 0.0001$), but not in the upper extremities (WMD = 2.27 kg; $P = 0.13$) or handgrip (WMD = 1.98 kg; $P = 0.46$). All trials were small and had methodological limitations. Resistance band training did not significantly affect HbA1c, upper extremity, or handgrip strength but significantly increased the strength of the lower extremities in people with type 2 diabetes.
Populations Analyzed: Adults; Type 2 diabetes	**Author-Stated Funding Source:** Doctoral awards and a Health Senior Scholar Award from the Alliance for Canadian Health Outcomes for Research in Diabetes, Alberta.

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Pai LW, Li TC, Hwu YJ, Chang SC, Chen LL, Chang PY. The effectiveness of regular leisure-time physical activities on long-term glycemic control in people with type 2 diabetes: a systematic review and meta-analysis. Diabetes Res Clin Pract. 2016;113:77-85. doi:10.1016/j.diabres.2016.01.011.</td></tr>
<tr><td>Purpose: To provide a pooled estimate of the beneficial effects of different types and overall regular leisure-time physical activities on long-term glycemic control in patients with type 2 diabetes.</td><td rowspan="5">Abstract: The objective of this study was to systematically review the effectiveness of different types of regular leisure-time physical activities and pooled the effect sizes of those activities on long-term glycemic control in people with type 2 diabetes compared with routine care. This review included randomized controlled trials from 1960 to May 2014. A total of 10 Chinese and English databases were searched, following selection and critical appraisal, 18 randomized controlled trials with 915 participants were included. The standardized mean difference was reported as the summary statistic for the overall effect size in a random effects model. The results indicated yoga was the most effective in lowering glycated haemoglobin A1c (HbA1c) levels. Meta-analysis also revealed that the decrease in HbA1c levels of the subjects who took part in regular leisure-time physical activities was 0.60% more than that of control group participants. A higher frequency of regular leisure-time physical activities was found to be more effective in reducing HbA1c levels. The results of this review provide evidence of the benefits associated with regular leisure-time physical activities compared with routine care for lowering HbA1c levels in people with type 2 diabetes.</td></tr>
<tr><td>Timeframe: 1960–May 2014</td></tr>
<tr><td>Total # of Studies: 18</td></tr>
<tr><td>Exposure Definition: Leisure-time PA interventions, including yoga, tai chi, walking, and quigong. Interventions lasted for 8–24 weeks and were held 2 to 3 times a week, with a duration of 90–720 minutes per episode. Subgroup analysis by type.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Glycated hemoglobin A1c levels.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults 35–71; Type 2 diabetes</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

Meta-Analysis **Citation:** Plotnikoff RC, Costigan SA, Karunamuni ND, Lubans DR. Community-based physical activity interventions for treatment of type 2 diabetes: a systematic review with meta-analysis. *Front Endocrinol (Lausanne)*. 2013;4:3. doi:10.3389/fendo.2013.00003.	
Purpose: To assess the effectiveness of community-based, PA interventions for the treatment of Type 2 diabetes in adult populations. **Timeframe:** 2002–June 2012 **Total # of Studies:** 22 (17 active PA interventions) **Exposure Definition:** Community-based PA intervention that ranged from 4 weeks to 24 months and included general exercise programs, walking programs, resistance training, and yoga classes. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Hemoglobin A1c levels. Fasting glucose. Weight and body mass index. PA levels. Quality of life. Diastolic and systolic blood pressure. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** Evidence suggests engaging in regular physical activity (PA) can have beneficial outcomes for adults with type 2 diabetes (TD2), including weight loss, reduction of medication usage and improvements in hemoglobin A1c (HbA1c)/fasting glucose. While a number of clinical-based PA interventions exist, community-based approaches are limited. The objective of this study is to conduct a systematic review with meta-analysis to assess the effectiveness of community-based PA interventions for the treatment of TD2 in adult populations. A search of peer-reviewed publications from 2002 to June 2012 was conducted across several electronic databases to identify interventions evaluated in community settings. Twenty-two studies were identified, and 11 studies reporting HbA1c as an outcome measure were pooled in the meta-analysis. Risk of bias assessment was also conducted. The findings demonstrate community-based PA interventions can be effective in producing increases in PA. Meta-analysis revealed a lowering of HbA1c levels by -0.32% [95% CI -0.65, 0.01], which approached statistical significance ($p < 0.06$). Our findings can guide future PA community-based interventions in adult populations diagnosed with TD2.
Populations Analyzed: Adults ≥18; Type 2 diabetes	**Author-Stated Funding Source:** National Health and Medical Research Council, Australia.

Meta-Analysis **Citation:** Qiu S, Cai X, Chen X, Yang B, Sun Z. Step counter use in type 2 diabetes: a meta-analysis of randomized controlled trials. *BMC Med*. Feb 2014a:36. doi:10.1186/1741-7015-12-36.	
Purpose: To evaluate the association of step counter use with PA as measured by steps/day, and glycemic control as represented by hemoglobin A1c; and to determine the association between PA goal-setting and improvement in PA and glycemic control in patients with type 2 diabetes.	**Abstract:** BACKGROUND: While step counter use has become popular among type 2 diabetes (T2D) patients, its effectiveness in increasing physical activity (PA) and improving glycemic control has been poorly defined. The aim of this meta-analysis of randomized controlled trials (RCTs) was to evaluate the association of step counter use with PA and glycemic control in T2D patients. METHODS: Articles were identified by searches of PubMed, Web of Science and Cochrane Library from January 1994 to June 2013. RCTs in the English language were included, if they had assessed the effectiveness of step counters as motivating and monitoring tools in T2D patients, with reported changes in steps per day (steps/d) or glycosylated hemoglobin A1c (HbA1c), or both. Data were independently collected by 2 authors and overall estimates were made by a random-effects model. RESULTS: Of the 551 articles retrieved, 11 RCTs were included. Step counter use significantly increased PA by 1,822 steps/d (7 studies, 861 participants; 95% confidence interval (CI): 751 to 2,894 steps/d) in patients with T2D. Step counter use with a PA goal showed a bigger increase in PA (weighted mean difference (WMD) 3,200 steps/d, 95% CI: 2,053 to 4,347 steps/d) than without (WMD 598 steps/d, 95% CI: -65 to 1,260 steps/d). Further subgroup analysis suggested step counter use with a self-set PA goal (WMD 2,816 steps/d, 95% CI: 1,288 to 4,344 steps/d) made no difference in increasing PA from a 10,000 steps/d goal (WMD 3,820 steps/d, 95% CI: 2,702 to 4,938 steps/d). However, no significant HbA1c change was observed by step counter use (10 studies, 1,423 participants; WMD 0.02%, 95% CI: -0.08% to 0.13%), either with (WMD 0.04%, 95% CI: -0.21% to 0.30%) or without a PA goal (WMD 0.01%, 95% CI: -0.10% to 0.13%). CONCLUSIONS: Step counter use is associated with a significant increase in PA in patients with T2D. However, evidence regarding its effect in improving glycemic control remains insufficient. TRIAL REGISTRATION: PROSPERO CRD42013005236.
Timeframe: January 1994–June 2013	
Total # of Studies: 11	
Exposure Definition: PA measured by steps/day using step counters. **Measures Steps:** Yes **Measures Bouts:** No **Examines HIIT:** No	
Outcomes Addressed: Changes in hemoglobin A1c (%). **Examine Cardiorespiratory Fitness as Outcome:** No	
Populations Analyzed: Adults; Type 2 diabetes	**Author-Stated Funding Source:** Key Program of Jiangsu Natural Science Foundation.

Meta-Analysis **Citation:** Qiu S, Cai X, Schumann U, Velders M, Sun Z, Steinacker JM. Impact of walking on glycemic control and other cardiovascular risk factors in type 2 diabetes: a meta-analysis. *PLoS One*. 2014b;9(10):e109767. doi:10.1371/journal.pone.0109767.	
Purpose: To examine the association of walking with glycemic control and other cardiovascular risk factors including weight reduction, blood pressure, and lipoprotein profiles among patients with type 2 diabetes, and to evaluate whether supervised walking would lead to better improvement in glycemic control versus nonsupervised walking among patients with type 2 diabetes. **Timeframe:** Inception–August 2014 **Total # of Studies:** 18 **Exposure Definition:** Structured, supervised or not supervised walking programs that were ≥8 weeks in duration. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Glycemic control: measured by hemoglobin A1c. Cardiovascular risk factors: assessed by weight reduction (body mass index [kg/m2]), systolic and diastolic blood pressure (mmHg), and lipoprotein profiles (high-density lipoprotein cholesterol and low-density lipoprotein cholesterol). **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** BACKGROUND: Walking is the most popular and most preferred exercise among type 2 diabetes patients, yet compelling evidence regarding its beneficial effects on cardiovascular risk factors is still lacking. The aim of this meta-analysis of randomized controlled trials (RCTs) was to evaluate the association between walking and glycemic control and other cardiovascular risk factors in type 2 diabetes patients. METHODS: Three databases were searched up to August 2014. English-language RCTs were eligible for inclusion if they had assessed the walking effects (duration >/=8 weeks) on glycemic control or other cardiovascular risk factors among type 2 diabetes patients. Data were pooled using a random-effects model. Subgroup analyses based on supervision status and meta-regression analyses of variables regarding characteristics of participants and walking were performed to investigate their association with glycemic control. RESULTS: Eighteen studies involving 20 RCTs (866 participants) were included. Walking significantly decreased glycosylated haemoglobin A1c (HbA1c) by 0.50% (95% confidence intervals [CI]: -0.78% to -0.21%). Supervised walking was associated with a pronounced decrease in HbA1c (WMD -0.58%, 95% CI: -0.93% to -0.23%), whereas non-supervised walking was not. Further subgroup analysis suggested non-supervised walking using motivational strategies is also effective in decreasing HbA1c (WMD -0.53%, 95% CI: -1.05% to -0.02%). Effects of covariates on HbA1c change were generally unclear. For other cardiovascular risk factors, walking significantly reduced body mass index (BMI) and lowered diastolic blood pressure (DBP), but non-significantly lowered systolic blood pressure (SBP), or changed high-density or low-density lipoprotein cholesterol levels. CONCLUSIONS: This meta-analysis supports that walking decreases HbA1c among type 2 diabetes patients. Supervision or the use of motivational strategies should be suggested when prescribed walking to ensure optimal glycemic control. Walking also reduces BMI and lowers DBP, however, it remains insufficient regarding the association of walking with lowered SBP or improved lipoprotein profiles. TRIAL REGISTRATION: PROSPERO CRD42014009515.
Populations Analyzed: Adults; Type 2 diabetes	**Author-Stated Funding Source:** No funding source used.

Systematic Review **Citation:** Rohling M, Herder C, Roden M, Stemper T, Mussig K. Effects of long-term exercise interventions on glycaemic control in type 1 and type 2 diabetes: a systematic review. *Exp Clin Endocrinol Diabetes*. 2016;124(8):487-494. doi:10.1055/s-0042-106293.	
Purpose: To summarize systematically effects of endurance, resistance, and combined training on glycemic control in long-term and supervised training interventions without calorie restriction in type 1 and type 2 diabetes. **Timeframe:** 2000–March 2015 **Total # of Studies:** 15 (13 Type 2 diabetes) **Exposure Definition:** Resistance, endurance, or combined training intervention, lasting at least 12 weeks. Stratified by intensity: endurance (moderate: 50–69% maximum heart rate [HR], vigorous: 70–85% max HR, intensive: >85% max HR), resistance (moderate: 50–74% one repetition maximum [1RM], vigorous: 75–85% 1RM, intensive: >85% 1RM). **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Glycemic control: measurements of hemoglobin A1c. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** Aim: Physical activity is one of the cornerstones in the prevention and management of diabetes mellitus, but the effects of different training forms on metabolic control still remain unclear. The aims of this review are to summarize the recommendations of 5 selected diabetes associations and to systematically review the effects of long-term supervised exercise interventions without calorie-restriction on glycemic control in people with type 1 and 2 diabetes focusing on resistance, endurance and combined training consisting of both endurance and resistance training. Methods: Literature searches were performed using MEDLINE for articles published between January 1, 2000 and March 17, 2015. Of 76 articles retrieved, 15 randomized and controlled studies met the inclusion criteria and allowed for examining the effect of exercise training in type 1 and 2 diabetes. Results: Diabetes associations recommend volume-focused exercise in their guidelines. In our analysis, all 3 training forms have the potential to improve the glycemic control, as assessed by HbA1c (absolute changes in HbA1c ranging from -0.1% to -1.1% (-1.1 to -12 mmol/mol) in resistance training, from -0.2% to -1.6% (-2.2 to -17.5 mmol/mol) in endurance training and from +0.1% to -1.5% (+1.1 to -16.4 mmol/mol) in combined training, respectively). Conclusions: There is evidence that combined exercise training may improve glycemic control to a greater extent than single forms of exercise, especially under moderate-intensive training conditions with equal training durations. In addition, intensity of training appears to be an important determinant of the degree of metabolic improvement. Nonetheless, it is still unknown to what extent exercise effects glycemic homeostasis.
Populations Analyzed: Type 2 diabetes	**Author-Stated Funding Source:** Not reported.

Pooled Analysis **Citation:** Sadarangani KP, Hamer M, Mindell JS, Coombs NA, Stamatakis E. Physical activity and risk of all-cause and cardiovascular disease mortality in diabetic adults from Great Britain: pooled analysis of 10 population-based cohorts. *Diabetes Care*. 2014;37(4):1016-1023. doi:10.2337/dc13-1816.	
Purpose: To examine the association between total PA and different PA types and the risk of all-cause and cardiovascular disease mortality in a population sample of diabetic patients drawn from representative general population samples from England and Scotland. **Total # of Studies:** Seven years of data from the Health Survey for England, and 3 years of data from the Scottish Health Survey. **Exposure Definition:** Frequency, duration, and intensity of 3 PA domains: sports and exercise, walking, and domestic physical activity (self-reported). Data converted into number of metabolic equivalent of task [MET]-hours per week. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** All-cause and cardiovascular disease mortality. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** OBJECTIVE To examine associations between specific types of physical activity and all-cause and cardiovascular disease (CVD) mortality in a large nationally representative sample of adults with diabetes from Great Britain. RESEARCH DESIGN AND METHODS There were a total of 3,038 participants (675 deaths) with diabetes in the Health Survey for England and the Scottish Health Surveys conducted between 1997 and 2008. Participants aged >/=50 years at baseline were followed up for an average of 75.2 months for all-cause and CVD mortality. Data were collected on self-reported frequency, duration, and intensity of participation in sports and exercise, walking, and domestic physical activity, from which the number of MET-hours/week were derived. Sex-specific medians of time spent in each type of physical activity (for those physically active) were calculated, and Cox proportional hazards regression conducted to examine type-specific associations between the level of physical activity and all-cause and CVD mortality risk. RESULTS Inverse associations with all-cause and CVD mortality were observed for overall physical activity in a dose-response manner after adjusting for covariates. Compared with those who individuals were inactive, participants who reported some activity, but below the recommended amount, or who met the physical activity recommendations had a 26% (95% CI 39-11) and 35% (95% CI 47-21) lower all-cause mortality, respectively. Similar results were found for below/above median physical activity levels. Sports and exercise participation was inversely associated with all-cause (but not CVD) mortality, as were above average levels of walking. Domestic physical activity was not associated with mortality. CONCLUSIONS Moderate physical activity levels were associated with better prognosis in diabetic adults.
Populations Analyzed: Adults ≥50; Type 2 diabetes	**Author-Stated Funding Source:** Scottish Executive; U.K. Department of Health and Social Care Information.

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Schwingshackl L, Missbach B, Dias S, Konig J, Hoffmann G. Impact of different training modalities on glycaemic control and blood lipids in patients with type 2 diabetes: a systematic review and network meta-analysis. Diabetologia. 2014;57(9):1789-1797. doi:10.1007/s00125-014-3303-z.</td></tr>
<tr><td>Purpose: To assess the efficacy of aerobic exercise training, resistance training, and combined training on glycemic control, blood pressure, and blood lipids in patients with type 2 diabetes mellitus.</td><td rowspan="5">Abstract: AIMS/HYPOTHESIS: This study aimed to systematically review randomised controlled trials comparing the effects of aerobic exercise training (AET), resistance training (RT) and combined training (CT) on glycaemic control and blood lipids in patients with type 2 diabetes mellitus. METHODS: Searches were performed in MEDLINE, EMBASE and the Cochrane Library. Inclusion criteria were: type 2 diabetes mellitus, adult, supervised training and a minimum intervention period of 8 weeks. Pooled effects were calculated by fixed/random effect pairwise and Bayesian fixed/random effects network meta-analyses. RESULTS: A total of 14 trials enrolling 915 participants were included. AET was more effective than RT in improving HbA1c levels (mean difference [MD] -0.20% [-2.2 mmol/mol]; 95% CI -0.32, -0.08; p = 0.0007, 10 trials/515 participants) and fasting glucose (MD -0.9 mmol/l; 95% CI -1.71, -0.09; p = 0.03, 8 trials/245 participants). Compared with AET, CT resulted in a significantly more pronounced reduction in HbA1c (MD -0.17% [-1.87 mmol/mol]; 95% CI -0.31, -0.03; p = 0.02, 9 trials/493 participants). Compared with RT, the MD of the change in HbA1c (MD -0.62%, [-6.82 mmol/mol]; 95% CI -0.95, -0.30; p = 0.0002, 5 trials/362 participants], fasting glucose (MD -1.99 mmol/l; 95% CI -3.07, -0.90; p = 0.0003, 3 trials/99 participants) and triacylglycerols (MD -0.28 mmol/l; 95% CI -0.46, -0.10; p = 0.003, 4 trials/213 participants) were all in favour of CT. The exclusion of trials with a high risk of bias yielded only non-significant results. CONCLUSIONS/INTERPRETATION: The present data suggest that CT might be the most efficacious exercise modality to improve glycaemic control and blood lipids. Interpretation with respect to clinical relevance is limited by the low quality of the studies included and the limited information on the clinically important outcomes or adverse effects of exercise.</td></tr>
<tr><td>Timeframe: Inception–May 2014</td></tr>
<tr><td>Total # of Studies: 14</td></tr>
<tr><td>Exposure Definition: Supervised, or partially supervised, exercise training consisting of either aerobic exercise training, resistance training, or a combination of both.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Reduction in hemoglobin A1c (mmol/mol). Body weight. Cholesterol: measured by low-density lipoprotein, high-density lipoprotein, and total cholesterol. Systolic and diastolic blood pressure (mmHg).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults ≥19; Obese (BMI: 30 and above); Type 2 diabetes</td><td>Author-Stated Funding Source: No funding source used.</td></tr>
</table>

Meta-Analysis **Citation:** Sluik D, Buijsse B, Muckelbauer R, et al. Physical activity and mortality in individuals with diabetes mellitus: a prospective study and meta-analysis. *Arch Intern Med*. 2012;172(17):1285-1295. doi:10.1001/archinternmed.2012.3130.	
Purpose: To investigate whether PA—total, leisure time, and walking—was associated with cardiovascular disease and total mortality in a large cohort of individuals with diabetes. **Timeframe:** Inception–2010 **Total # of Studies:** 12 **Exposure Definition:** Total PA was analyzed in 4 categories,and leisure-time PA (metabolic equivalent hours per week) and walking (hours per week) were analyzed in quartiles. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Mortality. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** BACKGROUND Physical activity (PA) is considered a cornerstone of diabetes mellitus management to prevent complications, but conclusive evidence is lacking. METHODS This prospective cohort study and meta-analysis of existing studies investigated the association between PA and mortality in individuals with diabetes. In the EPIC study (European Prospective Investigation Into Cancer and Nutrition), a cohort was defined of 5859 individuals with diabetes at baseline. Associations of leisure-time and total PA and walking with cardiovascular disease (CVD) and total mortality were studied using multivariable Cox proportional hazards regression models. Fixed- and random-effects meta-analyses of prospective studies published up to December 2010 were pooled with inverse variance weighting. RESULTS In the prospective analysis, total PA was associated with lower risk of CVD and total mortality. Compared with physically inactive persons, the lowest mortality risk was observed in moderately active persons: hazard ratios were 0.62 (95% CI, 0.49-0.78) for total mortality and 0.51 (95% CI, 0.32-0.81) for CVD mortality. Leisure-time PA was associated with lower total mortality risk, and walking was associated with lower CVD mortality risk. In the meta-analysis, the pooled random-effects hazard ratio from 5 studies for high vs low total PA and all-cause mortality was 0.60 (95% CI, 0.49-0.73). CONCLUSIONS Higher levels of PA were associated with lower mortality risk in individuals with diabetes. Even those undertaking moderate amounts of activity were at appreciably lower risk for early death compared with inactive persons. These findings provide empirical evidence supporting the widely shared view that persons with diabetes should engage in regular PA.
Populations Analyzed: Adults 30–75; Type 2 diabetes	**Author-Stated Funding Source:** European Foundation for the Study of Diabetes/sanofiaventis grant.

Systematic Review **Citation:** Sukala WR, Page R, Cheema BS. Exercise training in high-risk ethnic populations with type 2 diabetes: a systematic review of clinical trials. *Diabetes Res Clin Pract*. 2012;97(2):206-216. doi:10.1016/j.diabres.2012.02.001.	
Purpose: To systematically and critically evaluate clinical trials that have prescribed exercise training in high-risk, ethnic populations with type 2 diabetes mellitus and to summarize the metabolic adaptations to exercise noted in these trials. **Timeframe:** 1966–2011 **Total # of Studies:** 10 **Exposure Definition:** Aerobic and/or resistance training of 8 weeks duration or longer. Duration ranged from 8 to 52 weeks, 1 to 7 sessions per week. Aerobic training included walking, leg and arm cycle ergometry, and stepping. Intensity ranged from 50 to 85% of maximum intensity, and sessions ranged from 30 to 60 minutes. Resistance training intensity was moderate-to-high. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Hemoglobin A1c. Insulin action. Anthropometrics: body mass index, body composition. Blood lipids. Blood pressure. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** BACKGROUND: To review clinical trials that have prescribed exercise training in high-risk, ethnic populations with type 2 diabetes mellitus (T2DM) and delineate areas for future research. METHOD: A systematic review using computerized databases was performed. RESULTS: The systematic review located nine trials, including four uncontrolled trials, and five randomized controlled trials (RCTs) that included 521 participants. Cohorts studied included African, Indian, Polynesian, Hispanic, Arabian, and Chinese peoples and interventions included aerobic training, resistance training or a combination thereof. Several trials documented improvements in HbA1c, insulin action, body composition, blood lipids and systolic and diastolic blood pressure. In general, a longer duration and greater frequency of training resulted in greater adaptation. Studies demonstrating no effect were generally limited by an inadequate intervention. There was evidence of differential training responses between Caucasians and non-Caucasians in two studies drawing such comparisons. CONCLUSIONS: Robust RCTs prescribing appropriate, targeted interventions and investigating relevant outcomes may be required to stimulate greater advocacy for exercise as a therapeutic adjunct for diabetes management in these populations. Investigations should be extended to other high-risk populations, particularly indigenous peoples who suffer an extreme burden of T2DM. Translation of research into clinical application should remain the overall objective.
Populations Analyzed: Mean age 41–66; Type 2 diabetes	**Author-Stated Funding Source:** Not reported.

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Umpierre D, Ribeiro PA, Kramer CK, et al. Physical activity advice only or structured exercise training and association with HbA1c levels in type 2 diabetes: a systematic review and meta-analysis. Jama. 2011;305(17):1790-1799. doi:10.1001/jama.2011.576.</td></tr>
<tr><td>Purpose: To assess the associations of structured exercise training and PA advice on changes in hemoglobin A1c levels in patients with type 2 diabetes.</td><td rowspan="4">Abstract: CONTEXT: Regular exercise improves glucose control in diabetes, but the association of different exercise training interventions on glucose control is unclear. OBJECTIVE: To conduct a systematic review and meta-analysis of randomized controlled clinical trials (RCTs) assessing associations of structured exercise training regimens (aerobic, resistance, or both) and physical activity advice with or without dietary cointervention on change in hemoglobin A(1c) (HbA(1c)) in type 2 diabetes patients. DATA SOURCES: MEDLINE, Cochrane-CENTRAL, EMBASE, ClinicalTrials.gov, LILACS, and SPORTDiscus databases were searched from January 1980 through February 2011. STUDY SELECTION: RCTs of at least 12 weeks' duration that evaluated the ability of structured exercise training or physical activity advice to lower HbA(1c) levels as compared with a control group in patients with type 2 diabetes. DATA EXTRACTION: Two independent reviewers extracted data and assessed quality of the included studies. DATA SYNTHESIS: Of 4191 articles retrieved, 47 RCTs (8538 patients) were included. Pooled mean differences in HbA(1c) levels between intervention and control groups were calculated using a random-effects model. Overall, structured exercise training (23 studies) was associated with a decline in HbA(1c) level (-0.67%; 95% confidence interval [CI], -0.84% to -0.49%; I(2), 91.3%) compared with control participants. In addition, structured aerobic exercise (-0.73%; 95% CI, -1.06% to -0.40%; I(2), 92.8%), structured resistance training (-0.57%; 95% CI, -1.14% to -0.01%; I(2), 92.5%), and both combined (-0.51%; 95% CI, -0.79% to -0.23%; I(2), 67.5%) were each associated with declines in HbA(1C) levels compared with control participants. Structured exercise durations of more than 150 minutes per week were associated with HbA(1c) reductions of 0.89%, while structured exercise durations of 150 minutes or less per week were associated with HbA(1C) reductions of 0.36%. Overall, interventions of physical activity advice (24 studies) were associated with lower HbA(1c) levels (-0.43%; 95% CI, -0.59% to -0.28%; I(2), 62.9%) compared with control participants. Combined physical activity advice and dietary advice was associated with decreased HbA(1c) (-0.58%; 95% CI, -0.74% to -0.43%; I(2), 57.5%) as compared with control participants. Physical activity advice alone was not associated with HbA(1c) changes. CONCLUSIONS: Structured exercise training that consists of aerobic exercise, resistance training, or both combined is associated with HbA(1c) reduction in patients with type 2 diabetes. Structured exercise training of more than 150 minutes per week is associated with greater HbA(1c) declines than that of 150 minutes or less per week. Physical activity advice is associated with lower HbA(1c), but only when combined with dietary advice.</td></tr>
<tr><td>Timeframe: January 1980–February 2011</td></tr>
<tr><td>Total # of Studies: 47 (23 structured exercise training and 24 PA advice)</td></tr>
<tr><td>Exposure Definition: Structured exercise training regimens (aerobic, resistance, or both) and physical activity advice with or without dietary co-intervention.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No
Outcomes Addressed: Change in hemoglobin A1c.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults >18; Type 2 diabetes</td><td>Author-Stated Funding Source: Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).</td></tr>
</table>

Meta-Analysis **Citation:** Umpierre D, Ribeiro PA, Schaan BD, Ribeiro JP. Volume of supervised exercise training impacts glycaemic control in patients with type 2 diabetes: a systematic review with meta-regression analysis. *Diabetologia*. 2013;56(2):242-251. doi:10.1007/s00125-012-2774-z.	
Purpose: To determine the associations of characteristics of supervised exercise training with changes in hemoglobin A1c levels in patients with type 2 diabetes. **Timeframe:** January 1980–June 2012 **Total # of Studies:** 26 **Exposure Definition:** Supervised exercise training consisting of both aerobic and/or resistance training: the mean exercise frequency was 3 sessions/week, mean session duration was 48 minutes (not including warm-up and cool down), and mean exercise intensity was 74% of the maximum heart rate. Trials using resistance exercise training had an exercise frequency of 3 sessions/week, with intensities ranging from 60% to 85% of the 1-RM. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Hemoglobin A1c changes. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** AIMS/HYPOTHESIS: Supervised exercise programmes improve glycaemic control in type 2 diabetes, but training characteristics associated with reduction in HbA(1c) remain unclear. We conducted a systematic review with meta-regression analysis of randomised clinical trials (RCTs) assessing the association between intensity and volume of exercise training (aerobic, resistance or combined) and HbA(1c) changes in patients with type 2 diabetes. METHODS: Five electronic databases were searched (1980-2012) to retrieve RCTs of at least 12 weeks' duration, consisting of supervised exercise training vs no intervention, that reported HbA(1c) changes and exercise characteristics. Two independent reviewers conducted study selection and data extraction. RESULTS: Twenty-six RCTs (2,253 patients) met the inclusion criteria. In multivariate analysis, baseline HbA(1c) and exercise frequency explained nearly 58% of between-study variance. Baseline HbA(1c) was inversely correlated with HbA(1c) reductions after the three types of exercise training. In aerobic training, exercise volume (represented by frequency of sessions) was associated with changes in HbA(1c) (weighted r = -0.64), while no variables were correlated with glycaemic control induced by resistance training. In combined training, weekly volume of resistance exercise explained heterogeneity in multivariate analysis and was associated with changes in HbA(1c) levels (weighted r = -0.70). CONCLUSIONS/INTERPRETATION: Reduction in HbA(1c) is associated with exercise frequency in supervised aerobic training, and with weekly volume of resistance exercise in supervised combined training. Therefore, exercise volume is a major determinant of glycaemic control in patients with type 2 diabetes.
Populations Analyzed: Adults >18; Type 2 diabetes	**Author-Stated Funding Source:** Conselho Nacional de Desenvolvimento Científico e Tecnológico, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, and FIPE/HCPA.

Systematic Review **Citation:** van der Heijden MM, van Dooren FE, Pop VJ, Pouwer F. Effects of exercise training on quality of life, symptoms of depression, symptoms of anxiety and emotional well-being in type 2 diabetes mellitus: a systematic review. *Diabetologia*. 2013;56(6):1210-1225. doi:10.1007/s00125-013-2871-7.	
Purpose: To assess the effects of exercise training on quality of life, symptoms of depression, symptoms of anxiety and emotional well-being in people with type 2 diabetes. **Timeframe:** Inception–March 2012 **Total # of Studies:** 20 **Exposure Definition:** Exercise training defined as planned, structured, and repetitive bodily movement with the intention to improve or maintain one or more components of physical fitness. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Quality of life: assessed by questionnaires such as the 36-item Short-Form Health Survey or the abbreviated World Health Organization Quality of Life questionnaire. Symptoms of depression and anxiety: assessed by scales such as the Center for Epidemiologic Depression Scale (CES-D) or the Well-Being Questionnaire. Emotional Well-Being: assessed by the General Well-Being Questionnaire. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** AIMS/HYPOTHESIS: Psychological problems are relatively common in people with type 2 diabetes. It is unclear whether exercise training exerts an effect on quality of life, symptoms of depression, symptoms of anxiety and emotional well-being in people with type 2 diabetes. The aim of this study was to conduct a systematic review to assess the effects of exercise training on these outcomes in people with type 2 diabetes. METHODS: MEDLINE, PsycINFO, Embase and ClinicalTrials.gov databases were searched. The review included randomised controlled trials (RCTs) of at least 4 weeks' duration in people with type 2 diabetes that evaluated the effect of exercise training on quality of life, symptoms of depression, symptoms of anxiety and/or emotional well-being compared with usual care. RESULTS: Of 1,261 retrieved articles, 20 RCTs were included with a total of 1,719 participants. Quality of life was assessed in 16 studies. Between-group comparisons showed no significant results for aerobic training with the exception of one study, and mixed results for resistance and combined training. Symptoms of depression were assessed in four studies. In only one study did the intervention decrease symptoms of depression. Emotional well-being was evaluated in four studies, which also showed conflicting results. Symptoms of anxiety were evaluated in one study, which showed a significant improvement. CONCLUSIONS/INTERPRETATION: The effects of exercise training on psychological outcomes in people with type 2 diabetes are conflicting. Therefore, there is a need for further high-quality RCTs in order to gain greater insight into the role of exercise training in people with type 2 diabetes.
Populations Analyzed: Adults ≥18; Type 2 diabetes	**Author-Stated Funding Source:** Not reported.

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Vizcaino M, Stover E. The effect of yoga practice on glycemic control and other health parameters in type 2 diabetes mellitus patients: a systematic review and meta-analysis. Complement Ther Med. 2016;28:57-66. doi:10.1016/j.ctim.2016.06.007.</td></tr>
<tr><td>Purpose: To systematically assess and meta-analyze the current body of evidence, including the latest randomized controlled trials, on the effectiveness of yoga practice on the management of glycemic control in type 2 diabetes patients.</td><td rowspan="5">Abstract: • An analysis of the current literature that investigates the effects of yoga practice on the health of patients with type 2 diabetes.
• Current literature provides moderate evidence that yoga practice leads to improvements in fasting glucose compared to standard care alone.
• Yoga practice may also improve lipid profile and blood pressure in this population; however, additional research is needed.
• More well-designed and adequately reported randomized controlled trials that examine the effect of yoga on diabetes are needed.</td></tr>
<tr><td>Timeframe: Inception–2015</td></tr>
<tr><td>Total # of Studies: 15 (11 for meta-analysis)</td></tr>
<tr><td>Exposure Definition: Yoga-based intervention with a combination of postures and breathing techniques to improve self-awareness and attentional focus; majority were 3-month interventions with a focus on everyday yoga practice.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Fasting blood glucose, postprandial blood glucose, and hemoglobin A1c.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults 30–78; Type 2 diabetes</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

Meta-Analysis **Citation:** Yan JH, Gu WJ, Pan L. Lack of evidence on tai chi-related effects in patients with type 2 diabetes mellitus: a meta-analysis. *Exp Clin Endocrinol Diabetes*. 2013;121(5):266-271. doi:10.1055/s-0033-1334932.	
Purpose: To assess the efficacy of tai chi in type 2 diabetes mellitus. **Timeframe:** Inception–May 2012 **Total # of Studies:** 9 **Exposure Definition:** Tai Chi or taiji chuan exercise including "Tai Chi for Diabetes." Exercise time lasted 30–90 minutes. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Glucose control: fasting blood glucose, hemoglobin A1c, and insulin resistance. Lipids: Total cholesterol, high-density lipoprotein cholesterol, triglyceride. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** AIMS: Whether Tai Chi (TC) benefits patients with type 2 diabetes mellitus (T2DM) remains controversial. Thus, we performed a meta-analysis to assess the efficacy of TC in T2DM patients. METHODS: A computerised search through PubMed and Embase was performed to identify relevant studies. The primary outcomes were fasting blood glucose (FBG), haemoglobin A1c (HbA1c) and insulin resistance (HOMA). Secondary outcomes included total cholesterol, high-density lipoprotein cholesterol (HDL-C) and triglyceride. Weighted mean differences (WMDs) and 95% confidence intervals (CIs) were calculated. RESULTS: 4 randomised controlled trials (RCTs) and 5 non-randomised controlled trials (NRCTs) met the inclusion criteria. The pooled WMDs from RCTs were -14.82 mg/dL (95% CI: -49.17 to 19.53; P=0.40) for FBG, -0.19% (95% CI: -0.41 to 0.03; P=0.09) for HbA1c and -0.34 units (95% CI: -3.02 to 2.34; P=0.80) for HOMA. The WMDs from NRCTs were -11.22 mg/dL (95% CI: -18.58 to -3.86; P=0.003) for FBG, -0.41% (95% CI: -0.53 to -0.29; P<0.00001) for HbA1c and -0.60 units (95% CI: -1.46 to 0.25; P=0.16) for HOMA. Furthermore, the pooled results of serum lipids suggest that TC significantly reduced triglyceride (P=0.006) instead of total cholesterol (P=0.77), and failed to improve HDL-C (P=0.12). CONCLUSIONS: Sufficient evidence to support the benefits of TC to T2DM patients is lacking. Further large-scale studies are needed to investigate the long-term efficacy of TC.
Populations Analyzed: Type 2 diabetes	**Author-Stated Funding Source:** Not reported.

Meta-Analysis **Citation:** Yang Z, Scott CA, Mao C, Farmer AJ. Resistance exercise versus aerobic exercise for type 2 diabetes: a systematic review and meta-analysis. *Sports Med*. 2014;44(4):487-499. doi:10.1007/s40279-013-0128-8.	
Purpose: To compare the effects of resistance exercise with aerobic exercise on hemoglobin A1c as well as other measures of cardiovascular risk and safety in patients with type 2 diabetes. **Timeframe:** Inception–March 2013 **Total # of Studies:** 12 **Exposure Definition:** Resistance and aerobic exercise sessions ranging from 8 weeks to 12 months. Typically, 3 sessions of resistance exercise were taken per week, each session lasting for 30–60 minutes. The resistance exercises were conducted progressively and involved 5–10 muscle groups, with an intensity varying from 2 to 6 sets (mostly 2–3 sets) of 6 to 20 repetitions (mostly 8–12 repetitions) of each exercise. The major forms of aerobic exercises studied were cycling, walking, and treadmill. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Glycemic control: hemoglobin A1c (mmol/mol), fasting blood glucose (mmol/L), and insulin resistance (HOMA-IR). Blood lipids: low-density lipoprotein cholesterol (mmol/L), high-density lipoprotein cholesterol (mmol/L), total cholesterol (mmol/L), and triglycerides (mmol/L). Anthropometric measures: body mass index (kg/m2), body weight (kg), waist	**Abstract:** BACKGROUND: Resistance and aerobic exercises are both recommended as effective treatments for people with type 2 diabetes. However, the optimum type of exercise for the disease remains to be determined to inform clinical decision-making and facilitate personalized exercise prescription. OBJECTIVES: Our objective was to investigate whether resistance exercise is comparable to aerobic exercise in terms of effectiveness and safety in people with type 2 diabetes. DATA SOURCES: PubMed, EMBASE, CENTRAL, CINAHL, and SPORTdiscus were systematically searched up to March 2013. The reference lists of eligible studies and relevant reviews were also checked. STUDY SELECTION: We used the following criteria to select studies for inclusion in the review: (i) the study was a randomized controlled trial; (ii) the participants were people with type 2 diabetes aged 18 years or more; (iii) the trial compared resistance exercise with aerobic exercise for a duration of at least 8 weeks, with pre-determined frequency, intensity, and duration; and (iv) the trial provided relevant data on at least one of the following: glycaemic control, blood lipids, anthropometric measures, blood pressure, fitness, health status, and adverse events. STUDY APPRAISAL AND SYNTHESIS METHODS: The assessment of study quality was based on the Cochrane Risk of Bias tool. For effectiveness measures, differences (resistance group minus aerobic group) in the changes from baseline with the two exercises were combined, using a random-effects model wherever possible. For adverse events, the relative risks (resistance group vs. aerobic group) were combined. RESULTS: Twelve trials (n = 626) were included. Following the exercise interventions, there was a greater reduction of glycosylated hemoglobin with aerobic exercise than with resistance exercise (difference 0.18% (1.97 mmol/mol), 95% confidence interval (CI) 0.01, 0.36). This difference became non-significant with sensitivity analysis (p = 0.14). The differences in changes from baseline were also statistically significant for body mass index (difference 0.22, 95% CI 0.06, 0.39), peak oxygen consumption (difference -1.84 mL/kg/min, 95% CI -3.07, -0.62), and maximum heart rate (difference 3.44 beats per minute, 95% CI 2.49, 4.39). Relative risks for adverse events (all) and serious adverse events were 1.17 (95% CI 0.77, 1.79) and 0.89 (95% CI 0.18, 4.39), respectively. LIMITATIONS: Most included trials were short term (8 weeks to 6 months), and seven had important methodological limitations. Additionally, the meta-analyses for some of the secondary outcomes had a small number of participants or substantial statistical heterogeneity. CONCLUSIONS:

circumference (cm), body fat percentage (%), waist to hip ratio. Blood pressure: systolic and diastolic (mmHg). Fitness: VO2max (ml/kg/min). **Examine Cardiorespiratory Fitness as Outcome:** Yes	Although differences in some diabetic control and physical fitness measures between resistance exercise and aerobic exercise groups reached statistical significance, there is no evidence that they are of clinical importance. There is also no evidence that resistance exercise differs from aerobic exercise in impact on cardiovascular risk markers or safety. Using one or the other type of exercise for type 2 diabetes may be less important than doing some form of physical activity. Future long-term studies focusing on patient-relevant outcomes are warranted.
Populations Analyzed: Adults ≥18; Type 2 diabetes	**Author-Stated Funding Source:** Global Scholarship Programme for Research Excellence.

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Zou Z, Cai W, Cai M, Xiao M, Wang Z. Influence of the intervention of exercise on obese type II diabetes mellitus: a meta-analysis. Prim Care Diabetes. 2016;10(3):186-201. doi:10.1016/j.pcd.2015.10.003.</td></tr>
<tr><td>Purpose: To assess the effect of exercise intervention on the management of obese type 2 diabetes patients.</td><td rowspan="5">Abstract: AIM: The study aimed to assess the effect of exercise intervention on the management of obese T2DM patients. METHODS: The literature retrieval was conducted in relevant databases from their inception to 2015, with predefined searching strategy and selection criteria. The Cochrane Collaboration's tool was utilized to assess the quality of included studies. Weighted mean difference (WMD) with its corresponding 95% CI (confidence interval) was used as the effect size. RESULTS: A subset of 13 eligible studies was selected. Exercise significantly reduced the concentration of high sensitivity C reactive protein (4 months: WMD=-1.03, 95% CI: -1.77 to -0.29, P<0.01), triglyceride (6 months: WMD=-24.75, 95% CI: -27.67 to -21.83, P<0.01), diastolic blood pressure (6 months: WMD=-2.70, 95% CI: -4.12 to -1.28, P=0.0002), systolic blood pressure (WMD=-7.98, 95% CI: -9.87 to -6.08, P<0.01)), HbA1c (4 months: WMD=-0.25, 95% CI: -0.49 to -0.02, P=0.04) and homeostasis model assessment-insulin resistance (3 months: WMD=-0.19, 95% CI: -0.37 to -0.01, P=0.04); and a pronounced increase of HDL-C (12 months: WMD=3.57, 95% CI: 1.92 to 5.21, P<0.01). CONCLUSION: Exercise was beneficial to obese T2DM patients.</td></tr>
<tr><td>Timeframe: Inception–May 2015</td></tr>
<tr><td>Total # of Studies: 13</td></tr>
<tr><td>Exposure Definition: Exercise interventions ranging from 3 months to 3 years; the majority were aerobic exercise, and a few included resistance exercise and a combination of aerobic and resistance exercise.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: High-sensitivity C reactive protein, serum lipid, blood pressure (mm/Hg), hemoglobin A1c, and homeostasis model assessment insulin resistance.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Obese (BMI: 30 and above); Type 2 diabetes</td><td>Author-Stated Funding Source: Key Projects in the National Science & Technology Pillar Program.</td></tr>
</table>

Table 3. Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis Quality Assessment Chart

AMSTARExBP: SR/MA	Avery, 2012	Baskerville, 2017	Bhurji, 2016	Byrne, 2017	Cai, 2017	Chudyk, 2011	Cui, 2017
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	No	No	No	No	Yes
Comprehensive literature search performed.	Yes	Yes	Partially Yes	Yes	Partially Yes	Yes	Yes
Duplicate study selection and data extraction performed.	Yes	No	Yes	No	Yes	No	Yes
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes	No	Yes
Relevant grey literature included in review.	No	Yes	No	Yes	No	No	No
List of studies (included and excluded) provided.	No	No	No	No	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	N/A	No	N/A	N/A	N/A	No	No
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	Yes	Yes	Yes	No	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	No	Yes	No	No	N/A	Yes
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	Yes	Yes	Yes	N/A	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	Yes	N/A	N/A	N/A	Yes	Yes
Effect size index chosen justified, statistically.	Yes	Yes	N/A	N/A	N/A	Yes	Yes
Individual-level meta-analysis used.	No	No	N/A	N/A	N/A	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	Yes	Yes	No	No	No	No	Yes
Conflict of interest disclosed.	Yes	Yes	Yes	Yes	Yes	No	No

AMSTARExBP: SR/MA	Figueira, 2014	Freire, 2013	Funk, 2013	Grace, 2017	Gu, 2017	Hayashino, 2012	Hovanec, 2012
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	Yes	No	Yes	No	No	Yes	No
Comprehensive literature search performed.	Partially Yes	Yes	Partially Yes	Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	Yes	Yes	No	No	No	No	No
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	Yes	No	No	Yes	No	Yes	No
List of studies (included and excluded) provided.	No	No	No	No	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	No	N/A	N/A	Yes	N/A	Yes	No
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	No	Yes	Yes	Partially Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	Yes	N/A	No	No	Yes	No
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	N/A	Yes	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	N/A	N/A	Yes	N/A	Yes	Yes
Effect size index chosen justified, statistically.	Yes	N/A	N/A	Yes	N/A	Yes	Yes
Individual-level meta-analysis used.	No	N/A	N/A	No	N/A	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	Yes	No	No	Yes	No	Yes	No
Conflict of interest disclosed.	Yes	No	No	Yes	No	Yes	No

AMSTARExBP: SR/MA	Huang, 2016	Innes, 2016	Ishiguro, 2016	Kodama, 2013	Kumar, 2016	Lee, 2017	Lee, 2011
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	Yes	Yes	No	No	No
Comprehensive literature search performed.	Partially Yes	Yes	Yes	Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	Yes	No	No	Yes	Yes	Yes	No
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	Yes	No	No	No	No	No	Yes
List of studies (included and excluded) provided.	No	No	No	No	No	Yes	No
Characteristics of included studies provided.	Yes	Yes	No	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	No	N/A	Yes	No	No	Yes	No
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	Partially Yes	Partially Yes	Yes	Yes	Partially Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	Yes	Yes	Yes	Yes	No	No
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Effect size index chosen justified, statistically.	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Individual-level meta-analysis used.	No	N/A	No	No	No	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	Yes	No	Yes	Yes	Yes	No	No
Conflict of interest disclosed.	No	Yes	Yes	Yes	Yes	Yes	No

AMSTARExBP: SR/MA	Lee, 2015	Liubaoerjijin, 2016	McGinley, 2015	Pai, 2016	Plotnikoff, 2013	Qiu, 2014a	Qiu, 2014b
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	No	No	No	Yes	Yes
Comprehensive literature search performed.	Yes	Yes	Yes	Partially Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	Yes	Yes	Yes	No	No	Yes	Yes
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	Yes	Yes	No	Yes	No	No	No
List of studies (included and excluded) provided.	No	No	No	No	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	No	Yes	No	Yes	No	No	No
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	Yes	Partially Yes	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	No	Yes	Yes	No	No	No	Yes
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Effect size index chosen justified, statistically.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual-level meta-analysis used.	No	No	No	No	No	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	No	Yes	Yes	Yes	No	Yes	Yes
Conflict of interest disclosed.	Yes	Yes	Yes	No	Yes	Yes	Yes

AMSTARExBP: SR/MA	Rohling, 2016	Sadarangani, 2014	Schwingshackl, 2014	Sluik, 2012	Sukala, 2012	Umpierre, 2011	Umpierre, 2013
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	Yes	Yes	No	No	No	No
Comprehensive literature search performed.	Partially Yes	N/A	Yes	Partially Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	No	N/A	Yes	Yes	No	Yes	Yes
Search strategy clearly described.	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	No	N/A	Yes	No	No	No	No
List of studies (included and excluded) provided.	No	N/A	No	No	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes	Yes	No
FITT defined and examined in relation to outcome effect sizes.	N/A	Yes	No	No	N/A	No	Yes
Scientific quality (risk of bias) of included studies assessed and documented.	No	No	Yes	Yes	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	N/A	N/A	Yes	Yes	No	Yes	No
Scientific quality used appropriately in formulating conclusions.	N/A	N/A	Yes	Yes	No	Yes	No
Data appropriately synthesized and if applicable, heterogeneity assessed.	N/A	No	Yes	Yes	N/A	Yes	Yes
Effect size index chosen justified, statistically.	N/A	No	Yes	Yes	N/A	Yes	Yes
Individual-level meta-analysis used.	N/A	No	No	No	N/A	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	Yes	N/A	Yes	Yes	No	Yes	No
Conflict of interest disclosed.	No	Yes	Yes	Yes	No	Yes	Yes

AMSTARExBP: SR/MA	Van der Heijden, 2013	Vizcaino, 2016	Yan, 2013	Yang, 2014	Zou, 2016
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	No	No	No
Comprehensive literature search performed.	Yes	Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	Yes	Yes	No	Yes	Yes
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	Yes	Yes	No	Yes	Yes
List of studies (included and excluded) provided.	No	Yes	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	N/A	No	No	No	No
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	No	No	Yes	Yes
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	N/A	Yes	Yes	Yes	Yes
Effect size index chosen justified, statistically.	N/A	Yes	Yes	Yes	Yes
Individual-level meta-analysis used.	N/A	No	No	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	No	Yes	No	No	No
Conflict of interest disclosed.	No	No	No	Yes	Yes

Appendices

Appendix A: Analytical Framework

Topic Area
Chronic Conditions

Systematic Review Questions

In individuals with type 2 diabetes, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, (3) health-related quality of life, and (4) disease progression?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
c. Does the relationship vary based on: frequency, duration, intensity, type (mode), or how physical activity is measured?

Population
Individuals of all ages with diagnosed type 2 diabetes

Exposure
All types and intensities of physical activity, including sedentary behavior

Comparison
Individuals with type 2 diabetes who participate in varying levels of physical activity

Endpoint Health Outcomes

- Risk of co-morbid conditions
- Physical function
- Health-related quality of life
- Disease progression

Key Definitions

- Type 2 diabetes is a condition characterized by high blood glucose levels caused by either a lack of insulin or the body's inability to use insulin efficiently. (Source: American Diabetes Association: http://www.diabetes.org/diabetes-basics/common-terms/common-terms-s-z.html#sthash.ezhRSF7M.dpuf)
- Risk of co-morbid conditions: The chance of having one or more additional conditions.
- Physical function: “Physical function” and “physical functioning” are regarded as synonyms that refer to “the ability of a person to move around and to perform types of physical activity.”
  - For example, measures of physical function include measures of ability to walk (e.g., usually gait speed), run, climb stairs, carry groceries, sweep the floor, stand up, and bathe oneself.
  - As measures of behavioral abilities, physical function measures do not include:
    - Physiologic measures, including measures of physiologic capacity (e.g., maximal lung capacities, maximal aerobic capacity, maximal muscle strength, bone density).
    - Measures of the environment or of the host-environmental interaction (e.g., disability accommodation).
    - Measures of what a person usually does (e.g., physical activity level) as opposed to what a person is capable of doing.
- Health-related quality of life: “Health-related quality of life (HRQOL) is a multi-dimensional concept that includes domains related to physical, mental, emotional, and social functioning.” (Source: HealthyPeople.gov https://www.healthypeople.gov/2020/topics-objectives/topic/health-related-quality-of-life-well-being)
- Disease progression: A change or worsening of a disease over time.

Appendix B: Final Search Strategy

Supplementary Strategies: PubMed (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: PubMed; Date of Search: 5/11/2017; 1,060 results

Set	Search Strategy
Limit: Language	(English[lang])
Limit: Exclude animal only	NOT ("Animals"[mh] NOT ("Animals"[mh] AND "Humans"[mh]))
Limit: Publication Date (SR/MA)	AND ("2006/01/01"[PDAT] : "3000/12/31"[PDAT])
Limit: Publication Type Include (Systematic Reviews/Meta-Analyses)	AND (systematic[sb] OR meta-analysis[pt] OR “systematic review”[tiab] OR “systematic literature review”[tiab] OR metaanalysis[tiab] OR "meta analysis"[tiab] OR metanalyses[tiab] OR "meta analyses"[tiab] OR "pooled analysis"[tiab] OR “pooled analyses”[tiab] OR "pooled data"[tiab])
Limit: Publication Type Exclude (Systematic Reviews/Meta-Analyses)	NOT (“comment”[Publication Type] OR “editorial”[Publication Type])
Physical Activity	AND (("Aerobic endurance"[tiab] OR "Bicycl*"[tiab] OR "Endurance training"[tiab] OR "Exercise"[mh] OR "Exercise"[tiab] OR "Exercises"[tiab] OR "Free living activities"[tiab] OR "Free living activity"[tiab] OR "Functional training"[tiab] OR "Leisure-time physical activity"[tiab] OR "Lifestyle activities"[tiab] OR "Lifestyle activity"[tiab] OR "Muscle stretching exercises"[mh] OR "Physical activity"[tiab] OR "Qi gong"[tiab] OR "Recreational activities"[tiab] OR "Recreational activity"[tiab] OR "Resistance training"[tiab] OR "Running"[tiab] OR "Sedentary lifestyle"[mh] OR "Speed training"[tiab] OR "Strength training"[tiab] OR "Tai chi"[tiab] OR "Tai ji"[mh] OR "Tai ji"[tiab] OR "Training duration"[tiab] OR "Training frequency"[tiab] OR "Training intensity"[tiab] OR "Treadmill"[tiab] OR "Walking"[tiab] OR "Weight lifting"[tiab] OR "Weight training"[tiab] OR "Yoga"[mh] OR "Yoga"[tiab]) OR (("Aerobic activities"[tiab] OR "Aerobic activity"[tiab] OR "Cardiovascular activities"[tiab] OR "Cardiovascular activity"[tiab] OR "Endurance activities"[tiab] OR "Endurance activity"[tiab] OR "Physical activities"[tiab] OR "Physical conditioning"[tiab] OR "Sedentary"[tiab]) NOT medline[sb]))
Outcome	AND ("Diabetes"[tiab] OR “diabetes mellitus”[mh])

Supplementary Strategies: CINAHL (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: CINAHL; Date of Search: 5/11/2017; 29 results

All terms searched in title or abstract

Set	Search Terms
Physical Activity	("Aerobic endurance" OR "Bicycl*" OR "Endurance training" OR "Exercise" OR "Exercises" OR "Free living activities" OR "Free living activity" OR "Functional training" OR "Leisure-time physical activity" OR "Lifestyle activities" OR "Lifestyle activity" OR "Muscle stretching exercises" OR "Physical activity" OR "Qi gong" OR "Recreational activities" OR "Recreational activity" OR "Resistance training" OR "Running" OR "Sedentary lifestyle" OR "Speed training" OR "Strength training" OR "Tai chi" OR "Tai ji" OR "Tai ji" OR "Training duration" OR "Training frequency" OR "Training intensity" OR "Treadmill" OR "Walking" OR "Weight lifting" OR "Weight training" OR "Yoga" OR "Aerobic activities" OR "Aerobic activity" OR "Cardiovascular activities" OR "Cardiovascular activity" OR "Endurance activities" OR "Endurance activity" OR "Physical activities" OR "Physical conditioning" OR "Sedentary”)
Outcomes	AND ("Diabetes" OR “diabetes mellitus”)
Systematic Reviews and Meta-Analyses	(“systematic review” OR “systematic literature review” OR metaanalysis OR "meta analysis" OR metanalyses OR "meta analyses" OR "pooled analysis" OR “pooled analyses” OR "pooled data")
Limits	2006–present English language Peer reviewed Exclude Medline records Human

Supplementary Strategies: Cochrane (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

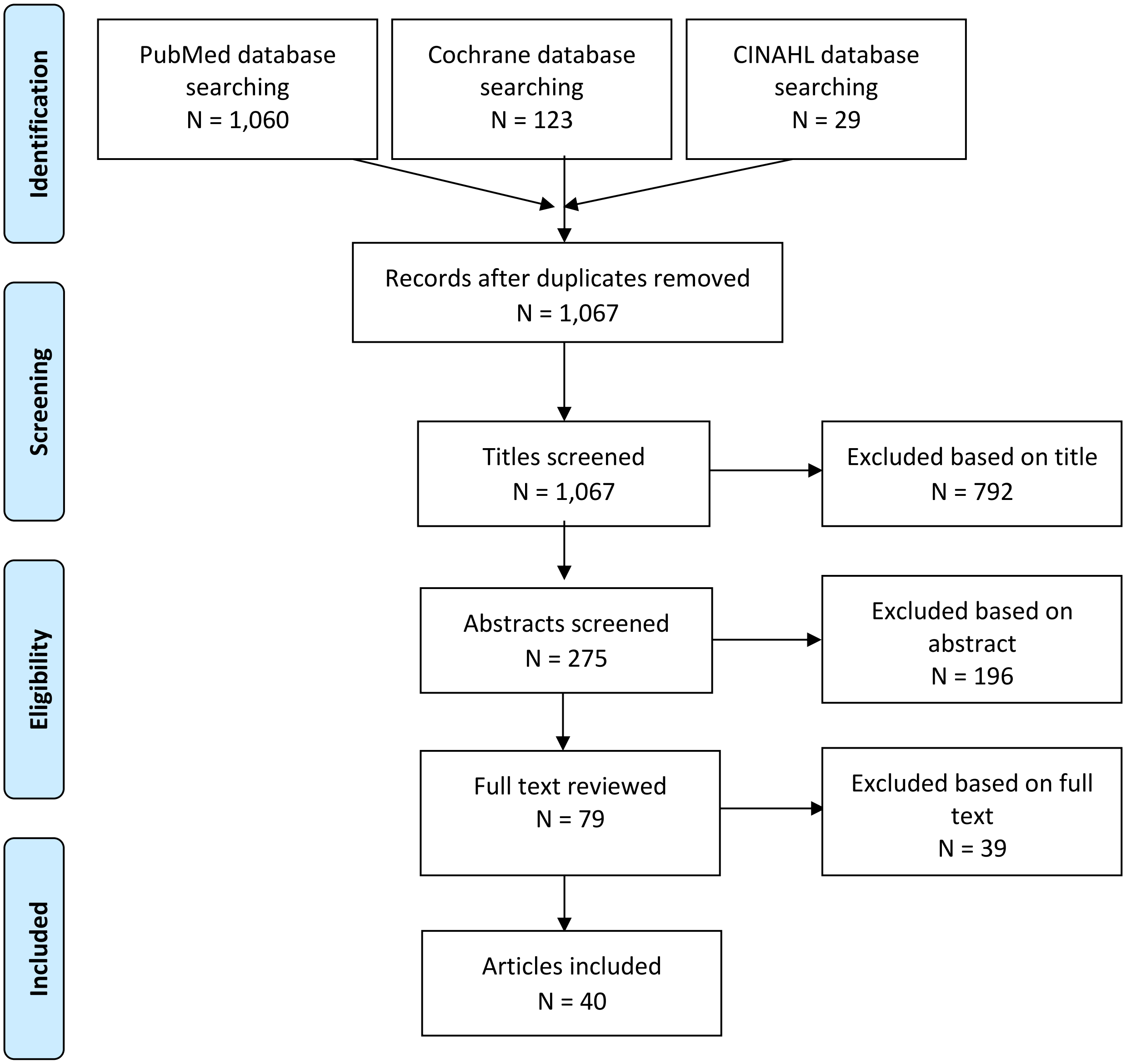
Database: Cochrane; Date of Search: 5/11/2017; 123 results

All terms searched in title, abstract, or keywords

Set	Search Terms
Physical Activity	("Aerobic endurance" OR "Bicycl*" OR "Endurance training" OR "Exercise" OR "Exercises" OR "Free living activities" OR "Free living activity" OR "Functional training" OR "Leisure-time physical activity" OR "Lifestyle activities" OR "Lifestyle activity" OR "Muscle stretching exercises" OR "Physical activity" OR "Qi gong" OR "Recreational activities" OR "Recreational activity" OR "Resistance training" OR "Running" OR "Sedentary lifestyle" OR "Speed training" OR "Strength training" OR "Tai chi" OR "Tai ji" OR "Tai ji" OR "Training duration" OR "Training frequency" OR "Training intensity" OR "Treadmill" OR "Walking" OR "Weight lifting" OR "Weight training" OR "Yoga" OR "Aerobic activities" OR "Aerobic activity" OR "Cardiovascular activities" OR "Cardiovascular activity" OR "Endurance activities" OR "Endurance activity" OR "Physical activities" OR "Physical conditioning" OR "Sedentary")
Outcomes	AND ("Diabetes" OR "diabetes mellitus")
Limits	2006–present Word variations not searched Cochrane Reviews and Other Reviews

Appendix C: Literature Tree

Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports Literature Tree



Appendix D: Inclusion/Exclusion Criteria

Chronic Conditions Subcommittee

Systematic Review Question: In individuals with type 2 diabetes, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, (3) health-related quality of life, and (4) disease progression?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
c. Does the relationship vary based on: frequency, duration, intensity, type (mode), or how physical activity is measured?

Category	Inclusion/Exclusion Criteria	Notes/Rationale
Publication Language	**Include:** • Studies published with full text in English	
Publication Status	**Include:** • Studies published in peer-reviewed journals • Reports determined to have appropriate suitability and quality by PAGAC **Exclude:** • Grey literature, including unpublished data, manuscripts, abstracts, conference proceedings	
Research Type	**Include:** • Original research • Meta-analyses • Systematic reviews • Reports determined to have appropriate suitability and quality by PAGAC	
Study Subjects	**Include:** • Human subjects	
Age of Study Subjects	**Include:** • People of all ages	
Health Status of Study Subjects	**Include:** • Studies of people with type 2 diabetes • Studies of people with type 2 diabetes in combination with other chronic conditions will be reviewed on a case by case basis **Exclude:** • Studies that include people with type 2 diabetes as part of the study sample, but do not analyze results separately for people with type 2 diabetes • Studies of people with type 1 diabetes only • Studies of people with prediabetes only	
Comparison	**Include:**	

	• Adults who participate in varying levels of physical activity, including acute or chronic exercise or no reported physical activity • Recreational athletes (marathons ok as long as the study looks at a diverse group of runners—not just the elites) **Exclude:** • High performance athletes • Studies comparing athletes to non-athletes • Studies comparing athlete types (e.g., comparing runners to soccer players)	
Date of Publication	**Include:** • Systematic reviews, meta-analyses, pooled analyses, and reports published from 2011–2016	
Study Design	**Include:** • Systematic reviews • Meta-analyses • Pooled analyses • PAGAC-approved reports **Exclude:** • Randomized controlled trials • Prospective cohort studies • Narrative reviews • Commentaries • Editorials • Non-randomized controlled trials • Retrospective cohort studies • Case-control studies • Cross-sectional studies • Before-and-after studies	
Intervention/ Exposure	**Include studies in which the exposure or intervention is:** • All types and intensities of physical activity, including sedentary behavior • Acute or chronic exercise **Exclude:** • Studies that do not include physical activity • Studies where physical activity is used solely as a confounding variable • Studies of multimodal interventions that do not present data on physical activity alone	

	• Studies of a disease-specific therapeutic exercise (e.g., rehabilitation) delivered by a medical professional (e.g., physical therapist) • Studies with measures of physical fitness as the exposure	

Outcome	**Include studies in which the outcome is:**
	• Risk of co-morbid conditions
	• Physical function
	• Health-related quality of life
	• Disease progression:
	  ○ Retinopathy: Disease of retina the results in impairment or loss of vision
	  ○ Nephropathy: Kidney damage or disease
	  ○ Neuropathy: Weakness, numbness, and pain from nerve damage, usually in hands or feet
	  ○ Diabetic foot (e.g., new onset of foot ulceration, foot infection, fracture of foot bones, or lower limb amputation)
	  ○ There is a relationship between hemoglobin A1c and retinopathy, nephropathy, and neuropathy; as such, a relationship between physical activity and hemoglobin A1c may be relevant	

Appendix E: Rationale for Exclusion at Abstract or Full-Text Triage for Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports

The table below lists the excluded articles with at least one reason for exclusion, but may not reflect all possible reasons.

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Not in date range	Other
Abdulameer SA, Sulaiman SA, Hassali MA, Subramaniam K, Sahib MN. Osteoporosis and type 2 diabetes mellitus: what do we know, and what we can do? *Patient Prefer Adherence*. 2012;6:435-448. doi:10.2147/PPA.S32745.				X			
Abubakari AR, Bhopal RS. Systematic review on the prevalence of diabetes, overweight/obesity and physical inactivity in Ghanaians and Nigerians. *Public Health*. 2008;122(2):173-182. doi:10.1016/j.puhe.2007.06.012.						X	
Abubakari AR, Lauder W, Jones MC, Kirk A, Agyemang C, Bhopal RS. Prevalence and time trends in diabetes and physical inactivity among adult West African populations: the epidemic has arrived. *Public Health*. 2009;123(9):602-614. doi:10.1016/j.puhe.2009.07.009.						X	
Adeniyi AF, Adeleye JO, Adeniyi CY. Diabetes, sexual dysfunction and therapeutic exercise: a 20 year review. *Curr Diabetes Rev*. 2010;6(4):201-206. doi:10.2174/157339910791658907.						X	
Afable A, Karingula NS. Evidence based review of type 2 diabetes prevention and management in low and middle income countries. World J Diabetes. 2016;7(10):209-229. doi:10.4239/wjd.v7.i10.209.							X
Aguiar EJ, Morgan PJ, Collins CE, Plotnikoff RC, Callister R. Efficacy of interventions that include diet, aerobic and resistance training components for type 2 diabetes prevention: a systematic review with meta-analysis. *Int J Behav Nutr Phys Act*. Jan 2014:2. doi:10.1186/1479-5868-11-2.		X					

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Not in date range	Other
Ahmad S, Shanmugasegaram S, Walker KL, Prince SA. Examining sedentary time as a risk factor for cardiometabolic diseases and their markers in South Asian adults: a systematic review. *Int J Public Health*. 2017;62(4):503-515. doi:10.1007/s00038-017-0947-8.		X					
Al Tunaiji H, Davis JC, Mackey DC, Khan KM. Population attributable fraction of type 2 diabetes due to physical inactivity in adults: a systematic review. *BMC Public Health*. May 2014:469. doi:10.1186/1471-2458-14-469.				X			
Aljasir B, Bryson M, Al-Shehri B. Yoga practice for the management of type II diabetes mellitus in adults: a systematic review. *Evid Based Complement Alternat Med*. 2010;7(4):399-408. doi:10.1093/ecam/nen027.						X	
Alothman S, Yahya A, Rucker J, Kluding PM. Effectiveness of interventions for promoting objectively measured physical activity of adults with type 2 diabetes: a systematic review. *J Phys Act Health*. 2017;14(5):408-415. doi:10.1123/jpah.2016-0528.	X						
Alouki K, Delisle H, Bermudez-Tamayo C, Jhori M. Lifestyle interventions to prevent type 2 diabetes: a systematic review of economic evaluation studies. *J Diabetes Res*. Jan 2016:2159890. doi:10.1155/2016/2159890.		X					
Alsairafi ZK, Taylor KM, Smith FJ, Alattar AT. Patients' management of type 2 diabetes in Middle Eastern countries: review of studies. *Patient Prefer Adherence*. June 2016:1051-1062. doi:10.2147/PPA.S104335.				X			
American Diabetes Association. Prevention or delay of type 2 diabetes. *Diabetes Care*. 2015;(38)(suppl 1):S31-S32. doi:10.2337/dc15-S008.	X						

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Not in date range	Other
Angermayr L, Melchart D, Linde K. Multifactorial lifestyle interventions in the primary and secondary prevention of cardiovascular disease and type 2 diabetes mellitus--a systematic review of randomized controlled trials. *Ann Behav Med*. 2010;40(1):49-64. doi:10.1007/s12160-010-9206-4.						X	
Antunes LC, Levandovski R, Dantas G, Caumo W, Hidalgo MP. Obesity and shift work: chronobiological aspects. *Nutr Res Rev*. 2010;23(1):155-168. doi:10.1017/S0954422410000016.						X	
Appuhamy JA, Kebreab E, Simon M, Yada R, Milligan LP, France J. Effects of diet and exercise interventions on diabetes risk factors in adults without diabetes: meta-analyses of controlled trials. *Diabetol Metab Syndr*. Nov 2014:127. doi:10.1186/1758-5996-6-127.		X					
Arambepola C, Ricci-Cabello I, Manikavasagam P, Roberts N, French DP, Farmer A. The impact of automated brief messages promoting lifestyle changes delivered via mobile devices to people with type 2 diabetes: a systematic literature review and meta-analysis of controlled trials. *J Med Internet Res*. 2016;18(4):e86. doi:10.2196/jmir.5425.				X			
Aune D, Norat T, Leitzmann M, Tonstad S, Vatten LJ. Physical activity and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis. *Eur J Epidemiol*. 2015;30(7):529-542. doi:10.1007/s10654-015-0056-z.		X					
Avery L, Flynn D, Dombrowski SU, van Wersch A, Sniehotta FF, Trenell MI. Successful behavioural strategies to increase physical activity and improve glucose control in adults with type 2 diabetes. *Diabet Med*. 2015;32(8):1058-1062. doi:10.1111/dme.12738.	X						

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Not in date range	Other
Avery L, Flynn D, Wersch A, Sniehotta FF, Trenell MI. Changing physical activity behavior in type 2 diabetes: a systematic review and meta-analysis of behavioral interventions. *Diabetes Care*. 2012;35(12):2681-2689. doi:10.2337/dc11-2452.				X			
Bian RR, Piatt GA, Sen A, et al. The effect of technology-mediated diabetes prevention interventions on weight: a meta-analysis*. J Med Internet Res*. 2017;19(3):e76. doi:10.2196/jmir.4709.		X					
Biswas A, Oh PI, Faulkner GE, et al. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis. *Ann Intern Med*. 2015;162(2):123-132. doi:10.7326/M14-1651.		X					
Blaha MJ, Bansal S, Rouf R, Golden SH, Blumenthal RS, Defilippis AP. A practical "ABCDE" approach to the metabolic syndrome. *Mayo Clin Proc*. 2008;83(8):932-941. doi:10.4065/83.8.932.						X	
Blohm D, Ploch T, Apelt S. Efficacy of exercise therapy to reduce cardiometabolic risk factors in overweight and obese children and adolescents: a systematic review. *Dtsch Med Wochenschr*. 2012;137(50):2631-2636. doi:10.1055/s-0032-1327333.				X			
Bosomworth NJ. Approach to identifying and managing atherogenic dyslipidemia: a metabolic consequence of obesity and diabetes. *Can Fam Physician*. 2013;59(11):1169-1180.			X				
Bravata DM, Smith-Spangler C, Sundaram V, et al. Using pedometers to increase physical activity and improve health: a systematic review. *Jama*. 2007;298(19):2296-2304. doi:10.1001/jama.298.19.2296.						X	

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Not in date range	Other
Brinks R, Hoyer A, Kuss O, Rathmann W. Projected effect of increased active travel in German urban regions on the risk of type 2 diabetes. *PLoS One*. 2015;10(4):e0122145. doi:10.1371/journal.pone.0122145.		X					
Brocklebank LA, Falconer CL, Page AS, Perry R, Cooper AR. Accelerometer-measured sedentary time and cardiometabolic biomarkers: a systematic review. *Prev Med*. July 2015:92-102. doi:10.1016/j.ypmed.2015.04.013.		X					
Brown SA, Garcia AA, Brown A, et al. Biobehavioral determinants of glycemic control in type 2 diabetes: a systematic review and meta-analysis. *Patient Educ Couns*. 2016;99(10):1558-1567. doi:10.1016/j.pec.2016.03.020.				X			
Brunton SA, Rolla AR. Implementing intensified treatment strategies for patients with type 2 diabetes mellitus. *J Fam Pract*. 2007;56(11)(suppl):S9-S16.						X	
Brunton SA. The changing shape of type 2 diabetes. *Medscape J Med*. 2008;10(6):143.						X	
Caffrey MK. Evidence builds on yoga, but no reimbursement yet. *Am J Manag Care*. 2014;20(8 Spec No.):E5.			X				
Cai X, Qiu SH, Yin H, et al. Pedometer intervention and weight loss in overweight and obese adults with type 2 diabetes: a meta-analysis. *Diabet Med*. 2016;33(8):1035-1044. doi:10.1111/dme.13104.	X						
Cayley WE. The role of exercise in patients with type 2 diabetes. *Am Fam Physician*. 2007;75(3):335-336.						X	
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Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Not in date range	Other
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